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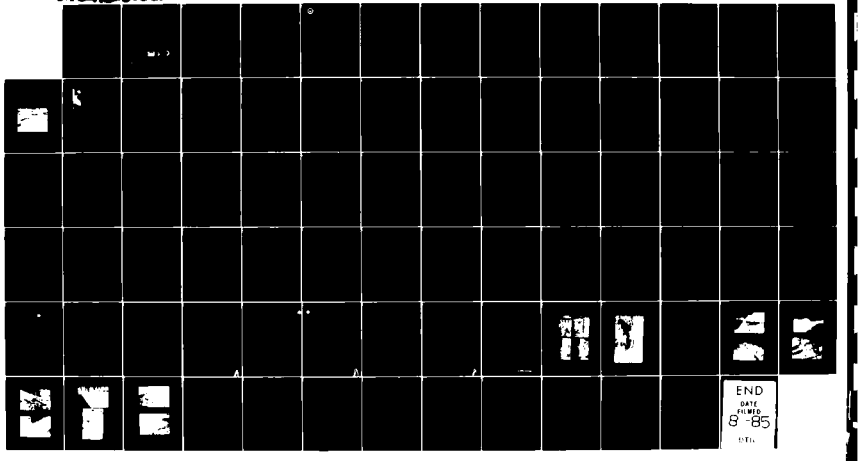

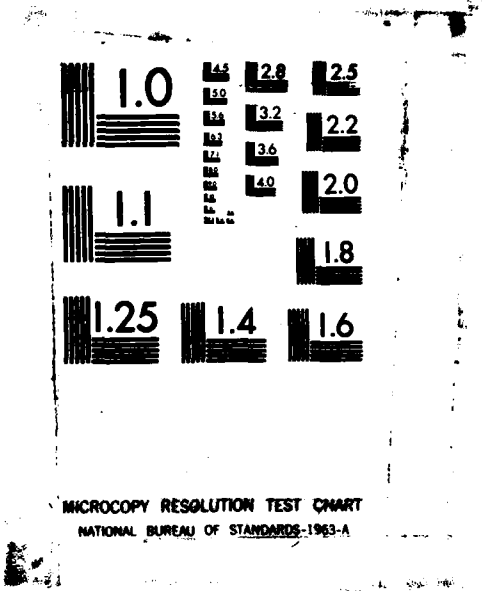
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MERRIMACK RIVER BASIN
LEOMINSTER, MASSACHUSETTS

FALL BROOK RESERVOIR DAM
MA 00869

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

SEPTEMBER 1979

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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Merrimack River Basin
Leominster Massachusetts
Fall Brook, tributary of the Nashua River

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The impounding structures at Fall Brook Reservoir include a 1392 ft. long, 37 ft. high main dam with a spillway and outlet, and a 256 ft. long, 11 ft. high dike. There are deficiencies which must be corrected to assure the continued performance of the dam. The dam is generally in fair condition. It has been classified as intermediate in size with a high hazard potential.

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REPLY TO
ATTENTION OF:
NEDED

DEC 17 1979

Honorable Edward J. King
Governor of the Commonwealth of
Massachusetts
State House
Boston, Massachusetts 02133

Dear Governor King:

Inclosed is a copy of the Fall Brook Reservoir Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Department of Environmental Quality Engineering, the cooperating agency for the Commonwealth of Massachusetts. In addition, a copy of the report has also been furnished the owner, city of Leominster.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Environmental Quality Engineering for your cooperation in carrying out this program.

Sincerely,

MAX B. SCHEIDER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

FALL BROOK RESERVOIR DAM

MA 00869

MERRIMACK RIVER BASIN
LEOMINSTER, MASSACHUSETTS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION
PROGRAM

NATIONAL DAM INSPECTION
PROGRAM

PHASE I INSPECTION REPORT

BRIEF ASSESSMENT

Identification No.: MA00869

Name of Dam: Fall Brook Reservoir

Town: Leominster

County and State: Worcester County, Massachusetts

Stream: Fall Brook - Tributary of the Nashua River

Date of Inspection: April 10, 1979

The impounding structures at Fall Brook Reservoir include a 1392-foot long, 37-foot high main dam with a spillway and outlet, and a 256-foot long, 11-foot high dike. The structures were built in 1896. According to available design drawings and construction photographs, the dam and dike are earthfill with a stone masonry core wall. The crest of the dam varies from El 657.0 to 657.7. The crest of the dike, which is an unpaved roadway, varies from El 656.2 to 656.6. The spillway is located at the south abutment of the dam, and consists of a broad-crested weir 19 feet long with vertical stone masonry training walls that extend the length of the discharge channel. The crest of the weir, which is covered with debris, is estimated to be at El 652.0. Water flowing over the spillway discharges into a stone-lined channel that is 19 feet wide and 390 feet long. The outlet for the dam consists of a 30-inch diameter cast-iron pipe which discharges at the toe of the dam.

There are deficiencies which must be corrected to assure the continued performance of this dam. This conclusion is based on the visual inspection of the site, a review of available data, including design drawings dated 1895, and a review of operation and and maintenance procedures. The dam is generally in "fair" condition.

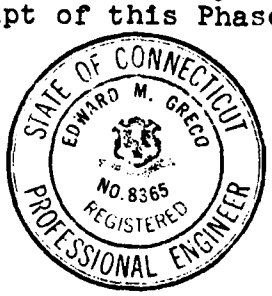
FALL BROOK RESERVOIR DAM

Based on Corps of Engineers' guidelines, the dam has been classified as "intermediate" size and in the "high" hazard category. A test flood equal to the full probable maximum flood (PMF) was used to evaluate the capacity of the spillway. The full PMF applied to the 1.31 square miles (838 acre) drainage area results in a test flood inflow of 3,670 cfs. The test flood outflow of 2,370 cfs and pool at El 657.6 will overtop the dam by 0.6 feet and the dike by 1.4 feet. The spillway capacity at El 656.2 (the low point on the crest of the dike) is 500 cfs, which is 21 percent of the test flood outflow.

A test flood equal to one-half the PMF would result in a test flood outflow of 760 cfs, at pool El 656.7. The flood would overtop the dike but not the dam.

It is recommended that the Owner employ a qualified engineering consultant to evaluate the seepage which is occurring through the embankment of the main dam, particularly in the area to the left of the outlet. The engineering consultant should also conduct a more detailed hydraulic and hydrologic study to evaluate spillway capacity and overtopping potential. In addition, the Owner should undertake the following measures to correct the deficiencies observed at the site: selectively clear trees and roots and remove all brush from the slopes of the dam and dike, and from the spillway discharge channel; clear the blocked outlet pipe and repair the outlet gate valve, if necessary; repair the headwall at the outlet and clear trees and debris from the outlet discharge channel; repair the training walls on the spillway; clear all rock, vegetation and debris from the crest of the spillway; backfill the eroded areas on the upstream slope of the dam and replace any missing riprap. In addition, the Owner should repair the deficiencies listed above, as described in Section 7.3. The Owner should also implement a program of annual technical inspections, a plan for surveillance of the embankment during and after periods of high runoff, and a plan for notifying nearby residents in the event of an emergency at the project.

The measures outlined above and in Section 7 should be implemented by the Owner within one year after receipt of this Phase I Inspection Report.



Edward M. Greco, P.E.
Project Manager
Metcalf & Eddy, Inc.

Connecticut Registration
No. 08365

Approved by:

Stephen L. Bishop, P.E.
Vice President
Metcalf & Eddy, Inc.

Massachusetts Registration
No. 19703

This Phase I Inspection Report on Fall Brook Reservoir Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

Joseph W. Finegan

JOSEPH W. FINEGAN, JR., MEMBER
Water Control Branch
Engineering Division

Joseph A. McElroy

JOSEPH A. MCELROY, MEMBER
Foundation & Materials Branch
Engineering Division

Carney M. Terzian

CARNEY M. TERZIAN, CHAIRMAN
Chief, Structural Section
Design Branch
Engineering Division

APPROVAL RECOMMENDED:

Joe B. Fryar

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in Recommended Guidelines for Safety Inspection of Dams, for a Phase I Investigation. Copies of these guidelines may be obtained from the Office of Chief Engineers, Washington, D.C., 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions will be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general conditions and the downstream damage potential.

FALL BROOK RESERVOIR DAM

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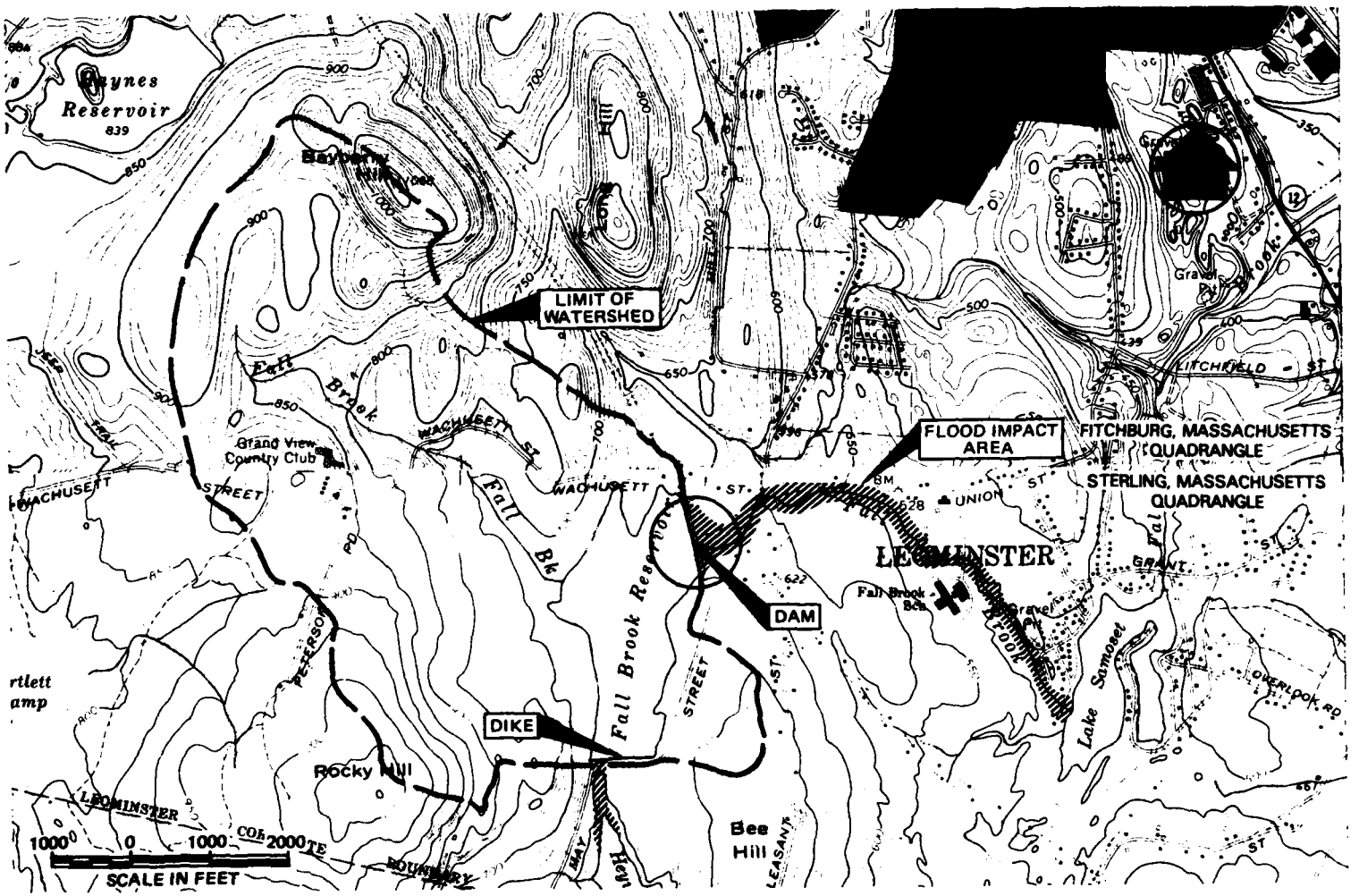
FALL BROOK RESERVOIR DAM
LEOMINSTER, MASSACHUSETTS



LOCATION MAP – FALL BROOK RESERVOIR DAM

NATIONAL DAM INSPECTION
PROGRAM

PHASE I INSPECTION REPORT

FALL BROOK RESERVOIR DAM

SECTION 1

PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, dated August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Metcalf & Eddy, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Contract No. DACW 33-79-C-0054, dated March 27, 1979 has been assigned by the Corps of Engineers for this work.

b. Purpose:

(1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) Encourage and assist the States to initiate quickly effective dam safety programs for non-Federal dams.

(3) Update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location. The dam is located on Fall Brook, a tributary of the Nashua River, in the City of Leominster, Worcester County, Massachusetts (see Location Map). The coordinates of this location are latitude 42 deg. 29.8 min. north and longitude 71 deg 46.8 min. west.

b. Description of Dam and Appurtenances. Fall Brook Reservoir Dam is an earthfill dam 37 feet high and 1,392 feet long (see Figures B-1, B-2, and B-4). The crest of the dam is about 20 feet wide, flat, and grass-covered. The high point of the dam is along the downstream edge of the crest, and ranges from El 657.0 to 657.7. The dam was constructed in 1896. The design drawing (Figure B-4) shows a core wall through the dam that is a maximum 2.5 feet wide at the top. Several photographs taken during construction and included in Appendix B show that the core wall consists of stone masonry.

The embankment upstream of the core wall was constructed of puddled earth, and the upstream face sloped at 2:1 (Horizontal:Vertical). This slope is protected with hand-placed riprap. The downstream side of the core wall consists of rolled earth with a 1.5:1 slope. The downstream face, which is partially grass-covered and overgrown with brush and trees, extends into the woods.

The left (north) abutment of the dam ends at Wachusett Street, which extends perpendicular to the axis of the dam. Two high-tension lines also cross the north end of the dam, from northwest to southeast. Two of the towers supporting the westerly power line are located at the site. One is at the north end of the pond, slightly upstream of the north abutment of the dam. The other is situated at the toe of the dam, about 400 feet south of the north abutment.

The right, or south abutment of the dam ties into natural ground in a wooded area. The spillway is located at the right abutment, and consists of a broad-crested weir with stone masonry training walls. The crest of the

spillway is a granite slab partially obscured by rubble and rock. The crest is 19 feet wide, and at El 652.0. The stone masonry core wall of the embankment continues under the crest of the weir and ties into the 5-foot high training walls on each side of the crest.

Upstream of the spillway crest the training walls slope into the reservoir. Downstream of the crest, the walls are 4 feet high, and extend for most of the length of the discharge channel, a total distance of 380 feet. About 60 feet downstream of the reservoir, the discharge channel turns south. The training walls are capped by granite blocks, and overgrown with vegetation. Six 4-inch diameter clay pipes which are at the base of the left wall serve as weep holes. The floor of the approach and discharge channels is lined with fieldstone, except at the downstream end of the discharge channel, which is covered by granite slabs. The floor of the discharge channel slopes at approximately 7 percent.

The outlet works at the dam consist of a 30-inch low-level outlet for draining the reservoir, and a 24-inch water supply main which is part of the municipal water supply system (see Figure B-4). The pipes extend from the gate well which is beneath the gate house, to the downstream toe of the dam. In Figure B-4, both pipes are shown as encased in stone, on a stone masonry bed, and it appears that seepage collars were constructed around the pipes, upstream and downstream of the core wall.

The gate house, which is located in the reservoir on the upstream slope of the dam, is a brick structure with a granite block foundation and a slate roof. Access to the gate house is provided by a walkway of iron and wooden planking. The door to the gate house is locked, and the former windows have all been blocked up with cinder blocks.

The interior of the gate house is empty except for two metal gate stems protruding from the wood floor. The inlet to the gate well is

covered by two screens which are visible through a hatchway in the floor of the gate house. The upstream screen is held in place by stoplogs above it, but the downstream set is removable for cleaning. Along the upstream wall of the gate house there is a wooden beam with rings. This is reportedly used when removing the screens.

The manually-operated gate valves have not been used for some time, and the necessary equipment for turning the gate stems is not kept in the gate house. The 30-inch diameter low-level outlet is kept closed at all times. The valve on the 24-inch water supply main is permanently open. When it becomes necessary to control flow through this line, a gate valve recently installed 150 feet downstream from the gatehouse is used.

The outlet of the 30-inch pipe terminates in a structure consisting of stone masonry wing walls and a headwall. The low-level outlet discharges into a poorly defined stream channel at the toe of the dam. According to records provided by the Owner, the 24-inch water supply main reduces to 20-inches just north of the outlet structure. The pipeline then turns northeast and passes through the manhole located beyond the toe of the dam. The manhole houses the gate valve on the pipeline that regulates flow to the chlorinator and pump station.

Discrepancies in the design drawing (Figure B-4) were noted during the Phase I survey and inspection. Figure B-4 shows that the invert of the 30-inch pipe was about 29 feet below the crest of the dam, which would be approximately at El 628. However, the field survey measured the downstream invert of the pipe at El 619.7. The drawing also shows the 24-inch water supply main continuing parallel to the 30-inch pipe up to the headwall at the outlet, rather than changing direction toward the manhole.

The dike is a 256-foot long earth embankment located along the south shore of Fall Brook Reservoir (see Location Map). The maximum

height of the embankment is 11 feet. According to Figure B-4, the dike contains a core wall about 20 feet high. The crest of the dike is a continuation of May Street, an unpaved road about 25 feet wide, and up to 70 feet wide at the right abutment. The elevation of the crest varies from 656.2 to 656.6. The upstream face slopes at about 2:1, and is covered with riprap. The downstream face slopes at 1.5:1 and is covered with grass and brush. The roadway continues west along the reservoir, beyond the dike. Here the upstream slope is covered with riprap, and the area beyond the downstream side is a swamp.

c. Size Classification. Fall Brook Reservoir Dam is in the "intermediate" size category since it has a maximum height of 37 feet and a maximum storage capacity of 1,633 acre-feet.

d. Hazard Classification. The area immediately downstream of the dam is undeveloped woodland and open fields. About 1,000 feet downstream Fall Brook flows in a culvert under Pleasant Street and through a residential development. At least 10 homes are situated on or close to the banks of the brook in this area. There is also moderate development along Lake Samoset, about 1.2 miles downstream of the dam. Failure of the dam at Fall Brook Reservoir would produce a flood wave about 16 feet high 1,000 feet downstream, as compared to a height of 2 feet prior to failure. This flood could result in extensive property damage and possible loss of life in the Pleasant Street and Lake Samoset areas. For this reason, the dam has been classified in the "high" hazard category.

e. Ownership. The dam is owned by the City of Leominster Department of Public Works, 109 Graham Street, Leominster, Massachusetts 01453. Mr. James McCaffrey, General Water Foreman of the Water Division (Telephone 617/537-8544) granted permission to enter the property and inspect the dam.

f. Operator. The dam is operated by personnel of the Water Division of the Department of Public Works for the City of Leominster, Massachusetts.

g. Purpose of Dam. The dam was built to provide storage for the City of Leominster water supply. The reservoir is at the head of the Intermediate Pressure System. Water from the reservoir can flow by gravity into the distribution system, or be pumped up into the high pressure system via the Pond Street Diversion Station.

h. Design and Construction History. Figure B-4, dated 1895, shows details of the core wall at the dam and dike, and construction of the gate house and outlet at the dam. The core wall continues under the spillway, and ties into the stone masonry training walls at each side of the spillway crest. There is no record of major reconstruction or repair work since construction of the dam and dike.

A 1929 inspection report mentioned a small leak at the gatehouse. In 1954 the inspector reported that repairs were made in the gate house but there is no other information available on the type or scope of the work.

The General Water Foreman does not recall any major work on either the dike or the dam within the last 20 years. The exceptions are the repair of vandalism to the gate house and selective clearing of trees on the downstream slope of the dam and in the spillway.

In 1976 the Town hired R.H. White Construction Co. to add a gate valve to the 20-inch water supply main. The valve is located in a manhole 50 feet east of the downstream toe of the dam. The inserted valve, rather than the gate valve in the gate house, controls the flow of water through the supply line to the chlorinator.

i. Normal Operating Procedures. Water from Fall Brook Reservoir can be discharged directly into the distribution system for the City, or can be pumped up to the High Pressure System for additional storage. In addition, the system can be reversed and the water pumped back up the line to the reservoir. When this

happens, a vane switch in the pipeline will automatically stop flow to the chlorinator. When the vane switch was installed, the gate valve was inserted on the 20-inch distribution line to cut off the flow in the pipe line. The valve is now used only when repairs to the vane switch are required.

The screens on the gate well are cleaned by back flushing at irregular intervals. The gate valves in the gate house are not used, and it is not known if they are still operable.

The 30-inch outlet pipe at the dam has not been used for many years. It is not known whether it is functioning properly.

1.3 Pertinent Data

a. Drainage Area. The approximately 838 acre (1.31 square miles) watershed is drained by Fall Brook which flows into the reservoir from the northeast (see Location Map). The topography is moderately steep and hilly, and except for a few small swamps, the reservoir is the only major pond in the watershed. The area consists of woods, farmland, and orchards. Development is limited to the Grand View Country Club, and less than 10 houses along Wachusett Street, May Street, and Peterson Road.

b. Discharge. Normal discharge is through the water supply main which conducts flow from the reservoir to the chlorinator, and eventually into the distribution system. When the height of the water in the reservoir exceeds El 652, discharge occurs over the crest of the spillway and into the stone lined channel leading to Fall Brook. The discharge channel is 19 feet wide and 390 feet long, with vertical stone masonry training walls. The channel bends to the northeast to join the Fall Brook channel about 250 feet downstream of the reservoir. The stream flows in a shallow channel filled with brush and small trees through swamps and open fields. About 400 feet below the dam, the stream enters a

small pool formed by a low earth mound at the east end of the pool (see Figure B-1). A channel has been cut through the mound to allow the stream to pass through, and the sides of the channel lined with rock. Beyond the mound Fall Brook flows through woods to Pleasant Street and beyond.

Discharge from the low-level outlet, if it could be opened, would flow in an overgrown stream channel that is not clearly defined until it joins the discharge from the spillway.

Hydraulic analyses indicate that the spillway can discharge an estimated 500 cfs with the reservoir at El 656.2, which is the low point on the crest of the dike. The test flood outflow (full PMF) is estimated to be 2,370 cfs with the water surface in the reservoir at El 657.6. The spillway can discharge 21 percent of the test flood outflow. During the test flood, the main dam would be overtopped by approximately 0.6 feet, and the dike by a maximum of 1.4 feet. The reservoir would also overflow into the swampy area below the east end of May Street, beyond the east abutment of the dike. In addition, the increased storage in the reservoir would cause some flooding on Wachusett Street, in a low area just upstream of the north abutment of the dam.

The maximum discharge rate at the dam is unknown. According to the Owner's representative, the dam and dike have never been overtopped.

c. Elevation (feet above mean sea level (MSL)). A benchmark was established at El 656.9 on a monel spike in the door sill of the gate house. This elevation was obtained from the Massachusetts Geodetic Survey.

(1) Top dam - Main dam: 657.0 to 657.7
Dike section: 656.2 to 656.6

(2) Test flood pool: 657.6

(3) Design surcharge (original design): Unknown

(4) Full flood control pool: Not Applicable (N/A)

(5) Recreation pool: N/A

(6) Spillway crest: 652.0

(7) Upstream portal invert diversion tunnel: N/A

(8) Streambed at centerline of dam: 619.7

(9) Tailwater: N/A

d. Reservoir

(1) Length of maximum pool: 3,500 feet

(2) Length of recreation pool: N/A

(3) Length of flood control pool: N/A

e. Storage (acre-feet)

(1) Test flood surcharge (net): 463 at El 657.6

(2) Top of dam (El 656.2, low point on dike): 1,633

(3) Flood control pool: N/A

(4) Recreation pool: N/A

(5) Spillway crest (El 652.0) 1,286

f. Reservoir Surface (acres)

*(1) Top dam: 82.6

*(2) Test flood pool: 82.6

(3) Flood control pool: N/A

*Based on the assumption that the surface area will not significantly increase with changes in reservoir elevation from 652.0 to 656.2.

(4) Recreation pool: N/A

(5) Spillway crest: 82.6

g. Dam

(1) Type - Main dam: earthfill embankment, stone masonry core wall,

- Dike section: earthfill embankment, stone masonry core wall

(2) Length - Main dam: 1,392 feet
- Dike section: 256 feet

(3) Height - Main dam: (maximum) 37 feet
- Dike section: (maximum) 11 feet

(4) Top width - Main dam: 20 feet
- Dike section: 25, to 70 feet (at right abutment)

(5) Side slopes - Main dam: downstream 1.5:1, upstream 2:1
- Dike section: downstream 1.5:1, upstream 2:1

(6) Zoning (dam and dike): stone masonry, core wall with embankment of earth fill

(7) Impervious core (dam and dike): stone masonry core wall

(8) Cutoff (dam and dike): stone masonry core wall extends 8 to 13 feet below embankment

(9) Grout curtain: None

h. Spillway

(1) Type: broad-crest; partially covered with rubble stone.

(2) Crest length: 19 feet

(3) Crest elevation: 652.0

(4) Gates: none

(5) Upstream channel: vertical stone masonry side walls slope 12 feet upstream; floor covered with fieldstone

(6) Downstream channel: 19 feet wide, 390 feet long; vertical stone masonry side walls extend 380 feet downstream, then into natural earth channel; floor is lined with stone, except at toe where there is a 10-foot long apron of granite slabs.

i. Regulating Outlets. The regulating outlet at the dam consists of a 30-inch diameter cast-iron pipe which extends from the gate well in the gate house to the downstream toe. The invert of the conduit at the toe is estimated at El 619.7. The outlet end of the pipe is partially filled by accumulated soil washed down from the slope. Flow is normally controlled by a gate valve in the gate house located on the upstream slope of the dam. Discharge is into a channel in the swampy area below the dam. The gate valve has not been operated in many years.

SECTION 2

ENGINEERING DATA

2.1 General. Several drawings, construction photographs and previous inspection reports, are available for the Fall Brook Reservoir Dam. Drawings showing the general layout of the reservoir, and details of the dam, dike, and outlet, were obtained from the Worcester County Engineering Department. These were dated 1895, and the details are included in Figure B-4 in Appendix B. A sketch dated January 3, 1976, showing the alterations to the 20-inch pipe and gate valve was obtained from the City of Leominster Department of Public Works, Water Division, but is not included in this report. Previous inspection reports were also obtained from the County Engineer's Office. No other plans, specifications, or computations are available from the Owner, County, or State agencies relative to the design, construction or repair of this dam.

We acknowledge the assistance and cooperation of personnel from the Massachusetts Department of Environmental Quality Engineering, Division of Waterways, the Massachusetts Department of Public Works, the Worcester County Engineers Office, and Mr. James McCaffrey of the Department of Public Works, Water Division.

2.2 Construction Records. The only construction records are the drawings referred to in Section 2.1 and included in Appendix B. There are no as-built drawings for the dam, dike or appurtenant structures. Construction photographs were reviewed at the office of the Water Division, and are included in Appendix B.

2.3 Operating Records. Records of volume discharged to the chlorinator and the distribution system are maintained by the Water Division. There is no daily record kept of the elevation of the water surface or rainfall at the site.

2.4 Evaluation

a. Availability. There is limited engineering data available.

b. Adequacy. The lack of detailed structural and construction data did not allow for a definitive review. Therefore, the evaluation of the adequacy of this dam is based on review of available drawings and past inspection reports, construction photographs, visual inspection, past performance history, and engineering judgment.

c. Validity. Comparison of the available drawings with the field survey conducted during the Phase I inspection indicates that the available information is valid. There is a discrepancy in the elevation of the pipe inverts between the 1895 drawing and the recent field survey. Also the final configuration of the two pipelines downstream of the dam has been altered from the original design.

SECTION 3

VISUAL INSPECTION

3.1 Findings

a. General. The Phase I Inspection of the dam and dike at Fall Brook Reservoir was performed on April 10, 1979. A second inspection of the dam was conducted on May 10, 1979, after the snow had melted. Photographs were taken at the site on April 10 and May 17, 1979. A copy of the inspection checklist is in Appendix A. Previous inspections were conducted by Worcester County from 1924 to 1964. The most recent report is included in Appendix B.

b. Dam. The dam is a 1,392-foot long, 37-foot high earth embankment, with a spillway at the south abutment and an outlet and gate house located about 400 feet from the spillway. An earth dike 256 feet long and 11 feet high is located at the south end of the reservoir.

The main dam is in fair condition. The soil on the downstream face and at the toe of the dam is moist and soft. One area of seepage was observed on the slope to the left of the outlet headwall (see Figure B-1). Photographs 5 and 6 in Appendix C show that much of the downstream slope is covered with a heavy growth of bushes, ferns, grapevines, and similar groundcover that prevented a closer examination of the slope. Several large diameter trees are also growing on the downstream slope. There is evidence of recent tree clearing on the slope, north of the outlet. However, the roots and stumps have been left in place.

The crest of the dam is flat and unpaved with no visible signs of settlement or erosion (see photo #3). Tire ruts on the surface are an indication of vehicular traffic. The upstream face of the dam is protected by riprap up to approximately El 653.5. On that portion of the slope that is visible above the waterline

the riprap appears to be in fair condition. Some of the stones have been removed, and there is minor slumping and erosion in the vicinity of the gate house walkway and the left training wall of the spillway. Small trees and brush are growing along the entire length of the upper upstream slope (see photo #1). Some vegetation is also growing between the riprap on the lower slope of the dam.

The embankment of the dike is in fair condition (see photos 9 and 10). The upstream slope is covered with hand-placed riprap. However, the face is partially obscured by small trees and brush growing along the upper slope, and between the riprap. There are numerous large diameter trees growing on the downstream slope of the dike. Apparently additional fill was dumped on the downstream slope, for reasons unknown. No seepage was observed along the dike. Standing water occurs in a naturally swampy area below the dike, and below the road embankment beyond the east abutment.

c. Appurtenant Structures. The spillway is a 19-foot long broad-crested weir at the south abutment of the dam. The granite blocks which comprise the crest of the spillway are mostly covered by rubble rock, earth, and vegetation (see Photo #8). The stone floor of the spillway is overgrown with vines and brush for the entire length of the channel. Several small trees growing through the floor of the channel have been cut down, but the stumps and roots remain. There is a barbed wire fence stretched across the natural channel, just downstream of the discharge channel.

The spillway crest, and approach and discharge channels, are bounded by stone masonry training walls with granite block caps. The walls are in fair to poor condition. The training walls to the approach channel slope upstream, and the granite cap on the left wall appears to have settled below the reservoir level. At some time in the past a large tree on the left abutment of the spillway was cut

down. The stump and roots remain, however, and there is also some erosion of the upstream slope at this location.

On other parts of the channel the training walls have deteriorated to the point that stones have fallen into the channel, leaving voids in the wall (see photo #7). The dense growth of vines, and roots from the many trees along the discharge channel also contribute to the deterioration.

Of the six weep holes in the left training wall, only the lowermost hole shows a significant amount of flow.

The outlet for the dam is a 30-inch diameter cast-iron pipe which discharges at the downstream toe of the dam, in a headwall constructed of stone masonry and granite blocks. The gate house is located on the upstream slope of the dam, in the reservoir, and contains the manually operated gate valve to control flow. The gate house is in fair condition. The former windows and arched doorway of the structure have been filled in with concrete blocks. A hole in the brickwork on the downstream wall of the gate house has not been repaired. There is a lock on the door, although it is in bad repair, and can be easily opened. The screens on the gate well, and the inlet to the outlet pipe, are submerged and were not visible for inspection. Part of the upstream foundation wall of the gate house was visible through the hatchway over the screens, where one granite block of the foundation appeared to be displaced about 1 inch. The walkway leading to the gate house is in fair condition. The iron facing is corroding, and the railing is bent. Also, a few wooden planks on the deck are starting to deteriorate.

The stems for the gate valves on both the low-level outlet and the water supply main protrude through the wooden floor of the gate

house. There are no operators for the valves at the site, and the Owner reports that neither valve is used any more. The gate on the low-level outlet is reportedly closed.

The discharge end of the outlet pipe is visible in the downstream toe of the dam at the granite and stone masonry outlet structure. The pipe is buried by soil for almost two-thirds of the diameter. Although the gate is closed, and no flow was detected from the outlet, there is a small pool of water directly downstream of the pipe, and in the former stream channel.

As shown in Photograph No. 4, the walls of the outlet structure are in poor condition. Settlement and erosion in the vicinity of the outlet structure has caused partial collapse of the walls. The granite cap on the right wing wall has fallen into the outlet channel.

d. Reservoir Area. Fall Brook Reservoir is used for a public water supply, and therefore commercial and residential development along the reservoir is prohibited. Instead much of the shoreline is filled with rows of pine trees planted by the City of Leominster to protect the watershed. The pines are also growing downstream of the dam, and along the spillway discharge channel. The remaining reservoir area is natural woodland, orchards, and farms, with slopes ranging from 3 to 14 percent.

e. Downstream Channel. The discharge channel below the spillway crest is paved with stone, and lined by stone masonry training walls. Beyond the spillway channel, water flows in a shallow stream through meadow and swampland. There are many small trees growing on the banks and overhanging the channel. Several dead trees are lying across the channel.

About 400 feet downstream, the flow in the stream channel is diverted by a low earth mound. The constriction created by a channel cut through the mound has caused a small pond

to form, and possibly contributes to the swamp as well. Once the flow is beyond the mound, the stream continues in a wooded area until it reaches a stone culvert under Pleasant Street, about 1,000 feet downstream of the reservoir. By this time the earth slopes of the channel are higher (about 5 feet), and a small waterfall is formed upstream of the culvert. The streambed is filled with cobbles, boulders, and brush.

The 30-inch low-level outlet has not been used in many years, and the discharge channel is barely discernible through the brush and fallen trees. The small pools of water in the former channel join the flow from the spillway just downstream of the spillway discharge channel.

3.2 Evaluation. The above findings indicate that the dam is in fair condition and that there are several deficiencies which require attention. It is evident that the dam is not adequately maintained. Recommended measures to improve these conditions are stated in Section 7.3.

SECTION 4

OPERATING PROCEDURES

4.1 Procedures. Personnel from the Leominster Water Division visit the dam at irregular intervals. Normal procedure at the dam is to leave the 30-inch outlet gate valve closed at all times, and the valve open on the 24-inch water supply main. Water flows by gravity to the chlorination station near Pleasant Street and into the distribution system. It is also possible to reverse the process and pump water back up to the reservoir from the high pressure system. This is only done during periods of low water to maintain the maximum storage and head in Fall Brook Reservoir. There is no program of flood control at the dam.

4.2 Maintenance of the Dam. Maintenance of the dam has been limited to some selective clearing of trees and brush on the slopes of the dam, and in the spillway channel. Present conditions at the dam indicate that it has not been adequately maintained.

4.3 Maintenance of Operating Facilities. The gate valves in the gate house have not been operated in many years. The 30-inch low-level outlet pipe is closed at all times, and the outlet end of the pipe has been partially buried by soil washed into the channel from the slope. Flow through the water supply main can now be controlled by a valve housed in a manhole at the downstream toe of the dam. The manhole was not inspected, but the valve, which was installed in 1976, is reportedly in operable condition.

The gate house is not adequately maintained. The arched doorway and windows had to be blocked up years ago due to vandalism. Inside the gate house in the gate well, the screens are periodically cleaned by backflushing from the water supply system. According to the Owner, a diver has also been employed in the past to check the screens.

4.4 Description of Any Warning System in Effect. There is no warning system in effect at this dam.

4.5 Evaluation. The maintenance program at Fall Brook Reservoir Dam is inadequate. There is no program of technical inspections or any warning system in effect at the dam. This is extremely undesirable considering the dam is in the "high" hazard category. A regular program of inspection and maintenance and a surveillance system for this dam should be implemented as recommended in Section 7.3.

SECTION 5

HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. General. The impounding structures on Fall Brook Reservoir consist of a 1,392-foot long earth dam, and a 256-foot long earth dike. The crest of the dike is approximately 0.8 feet below the crest of the main dam. The drainage area for the reservoir is 1.31 square miles of very sparsely developed wood- and farmland. Fall Brook drains into the reservoir from the northwest. Except for a few swamps, there are no other major bodies of water in the drainage area. The valley below the dam is a broad meadow for about 1,000 feet. A low earth mound about 400 feet downstream restricts the Fall Brook to a small channel cut through the embankment. As a result of this constriction, a small pond and swamp area have been formed upstream of the mound. Moderate residential development occurs along Fall Brook about 1,000 feet downstream of the dam. The brook discharges into Lake Samoset about 1.2 miles downstream.

Fall Brook Reservoir is part of the water supply system for the City of Leominster. Maximum storage in the reservoir is calculated to be 1,633 acre-feet. Normal storage, to the crest of the spillway, is 1,286 acre-feet. The maximum flood level is unknown. According to the Owner the dam has never been overtopped.

The 30-inch outlet pipe can discharge a flow of 139 cfs when the level of the reservoir is at El 652, the crest of the spillway. From that elevation, and assuming no inflow, the outlet can lower the reservoir by 1 foot in about 7 hours.

b. Design Data. There are no hydraulic or hydrologic computations available for the design of the spillway at Fall Brook Reservoir Dam.

c. Experience Data. Operating records are not available for the dam. According to the Owner, over one million gallons per day are drawn from the reservoir and either sent directly into the distribution system or to other parts of the system where storage is available. The Owner notes that flooding at the dam has never been a problem and that the low level outlet has never been used for lowering the water level.

d. Visual Inspection. Water flows over the spillway and down a channel bounded by stone masonry training walls. The crest is 19 feet long and at El 652.0. There are no stoplogs or flashboards on the crest. The discharge channel is rectangular, 19 feet wide, and 390 feet long. The channel turns to the north about 60 feet downstream. The floor of the channel, which is paved with stone, slopes at about 7 percent. The training walls are 4 to 5 feet high.

Below the end of the spillway discharge channel, the stream joins flow from the outlet in a low swampy area. Fall Brook continues downstream in a shallow, natural channel.

Tree stumps left standing in the floor of the spillway channel, loose rocks fallen from the training walls, and a heavy growth of vines in the channel all act as obstructions to flow through the spillway. In addition, there is a barbed wire fence stretched across the end of the discharge channel that could collect wood and debris.

The outlet for the dam is a 30-inch cast iron pipe that discharges into an undefined channel at the toe of the dam. The outlet gate is closed, but there is a pool of water below the discharge point that may be due to leakage through the gate, or seepage along the pipe. The outlet pipe is partially buried by soil washed down from the slope. The discharge channel is overgrown with vegetation, and several large trees have fallen across the channel.

Additional observations of the condition of the dam and appurtenances are given in Section 3, Visual Inspection.

e. Test Flood Analysis. Fall Brook Reservoir Dam has been placed in the "intermediate" size category and the "high" hazard category. According to Corps of Engineer's guidelines the full Probable Maximum Flood (PMF) should be used to evaluate the capacity of the spillway.

The PMF for Fall Brook Reservoir Dam was determined to be 2,800 cfs per square mile of drainage area. This calculation is based on the average slope of the drainage area of 8 percent, the pond-plus-swamp area to drainage area ratio of 2 percent, and the U.S. Army Corps of Engineers' guide curves for Maximum Probable Flood Peak Rates (dated December 1977). Applying the full PMF to the 1.31 square miles of drainage area results in a calculated peak flood flow of 3,670 cfs as the test flood inflow. By adjusting the test flood inflow for surcharge storage, the maximum discharge rate was established as 2,370 cfs (1,089 cfs per square mile) with the level of the pond at El 657.6.

Hydraulic analyses indicate that the spillway can discharge a maximum of 500 cfs with the pond at El 656.2 which is the approximate low point on the crest of the dike. This discharge is 21 percent of the test flood outflow. During the test flood, the main dam would be overtopped by about 0.6 feet and the dike would be overtopped by a maximum of 1.4 feet. During the test flood, discharge over the spillway and crest of the dam is estimated to be 1210 cfs. The depth at critical flow would be 0.35 feet, at a velocity of 3.35 feet per second. The discharge over the crest of the dike is estimated to be 1160 cfs. The depth at critical flow would be 0.82 feet with a velocity of 5.14 feet per second.

f. Dam Failure Analysis. The peak discharge rate due to failure of the main dam was calculated to be 37,700 cfs, assuming a breach 160 feet wide and a head of 27.0 feet. Prior to failure, the spillway would be discharging 640 cfs into Fall Brook. Failure of the dam would produce a flood wave about 16 feet high approximately 1,000 feet downstream, as compared to a height of about 2 feet prior to failure. The flood would overtop Pleasant Street and could result in extensive damage to residential property along Union Street and Fall Brook, and also to the homes along the brook west of Lake Samoset, about 1.2 miles away from the dam. About 10 homes could be damaged by the flood wave. It is possible that such a major flood would also cause the loss of more than a few lives in these areas. For this reason the dam has been placed in the high hazard category.

The peak discharge rate due to failure of the dike was calculated to be 3,880 cfs, assuming a 66-foot-wide breach and a head of 10.7 feet. Failure would produce a flood wave about 3.8 feet high that would flow directly into Heywood Reservoir, about 700 feet downstream of the dike. The area between the two reservoirs is undeveloped woodland that would experience only minor damage.

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations. The evaluation of the structural stability of the dam and dike at Fall Brook Reservoir is based on a review of the available data, a review of previous inspection reports and construction photographs, and visual inspections conducted on April 10 and May 10, 1979.

As discussed in Section 3, Visual Inspection, the dam and dike are in fair condition. Seepage was observed at the downstream toe, near the outlet, and much of the slope was soft and moist as well. The heavy growth of brush and vines on the slope prevented a closer inspection of the area for seepage or settlement. It is recommended that the Owner employ a qualified consultant to further evaluate the condition of the slope and the stability of the dam.

b. Design and Construction Data. The dam and dike were constructed in 1896. A drawing (Figure B-6) dated 1895 and signed by Charles A. Allen, Engineer, shows the core wall in plan and profile for both embankments. The top of the core wall at the main dam is 2.5 feet thick and at approximately El 656, which is about 4 feet above the crest of the spillway. According to the drawing, the total height of the core wall is about 41 feet, and the thickness increases to 6.5 at the bottom. The foundation material for the core wall is unknown.

Figure B-6 also shows that the outlet pipe is encased in stone, on a stone bed, and passes through the dam from the gate house to the downstream toe. Seepage collars were constructed on the pipeline on each side of the core wall. The core wall for the dike is 2 feet thick and 20 feet high. The foundation material for the dike is unknown.

In Figure B-4, the embankments are described as being made of puddled earth on the upstream slope, and rolled earth on the downstream slope. No other plans or specifications are available concerning the details of construction of the dam and dike, or the type, shear strength or permeability of the soil in the embankments.

c. Operating Records. There is no instrumentation of any type in the embankment at Fall Brook Reservoir Dam, and no instrumentation was ever installed at this site. The performance of the embankment under prior loading can only be inferred by physical evidence at the site.

d. Post-Construction Changes. A gate valve on the 20-inch water supply line was installed in 1976 to control flow to the chlorinator. No other post-construction changes were reported.

e. Seismic Stability. The dam is located in Seismic Zone No. 2 and according to recommended guidelines does not warrant seismic analysis at this time.

SECTION 7

ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. Based upon a review of available data, the visual inspection of the site, and limited operational or maintenance information, there are deficiencies which must be corrected to assure the continued performance of the dam. Seepage was observed on the downstream slope of the dam, to the left of the outlet, and soil on much of the remaining slope was moist and soft. Several other signs of distress were also observed: dense growth of trees, brush, and vines, particularly on the downstream slope of the dam; obstructions including rocks, tree stumps, and debris in the floor of the spillway channel; deterioration of the training walls on the spillway; the blocked outlet pipe and collapsing walls of the outlet structure; standing water downstream of the outlet pipe; dead trees fallen across the outlet discharge channel; and minor erosion and missing riprap from the upstream slope. The earth dike contains trees and brush on both the upstream and downstream slopes.

Hydraulic analyses indicate that the spillway can discharge an estimated flow of 500 cfs with the reservoir at El 656.2, which is the approximate low point on the crest of the dike. An outflow test flood (full PMF) of 2,370 cfs will overtop the dam by 0.6 feet, and the dike by 1.4 feet. The spillway can discharge 21 percent of the outflow test flood before the dike is overtopped.

b. Adequacy. The lack of detailed design and construction data did not allow for a definitive review. Therefore, the evaluation of the adequacy of this dam is based on a review of the available data, the visual inspection, past performance and engineering judgment.

c. Urgency. The recommendations and remedial measures outlined below should be implemented by the Owner within one year after receipt of this Phase I Inspection Report.

d. Need for Additional Investigation. Additional investigations to further assess the adequacy of the dam are outlined below in Section 7.2, Recommendations.

7.2 Recommendations. In view of the concerns over the continued performance of the dam, it is recommended that the Owner employ a qualified engineering consultant to:

a. Conduct a geotechnical investigation to evaluate the seepage through the main dam.

b. Develop a program of selective clearing of trees and roots from the embankment, particularly the downstream slope, and along the spillway and outlet discharge channels. All excavations for stumps and roots should be backfilled with selected materials.

c. Conduct a more detailed hydraulic and hydrologic investigation to evaluate spillway capacity and overtopping potential.

The Owner should implement the recommendations of the engineering consultant which result from these investigations.

7.3 Remedial Measures

a. Operating and Maintenance Procedures. It is recommended that the Owner accomplish the following:

(1) Immediately clear the blocked outlet pipe and repair the 30-inch outlet gate valve, if necessary. If in the future, major repair work is performed on the dam the Owner should consider repairing or replacing the water supply main valve located in the gate house.

(2) Repair the stone headwall at the outlet, and clear trees and debris from the outlet discharge channel.

(3) Clear all brush and vines on the slopes, and from the spillway channel and training walls.

(4) Clear wood, stone and debris from the crest and floor of the spillway.

(5) Repair the stone masonry training walls of the spillway.

(6) Backfill the eroded areas on the upstream slope of the dam, and replace any missing riprap.

(7) Repair the lock on the gate house door, and replace the wooden planks on the walkway where necessary.

(8) Implement a systematic program of maintenance inspections. As a minimum, the inspection program should consist of a monthly inspection of the dam, dike and appurtenances, supplemented by additional inspections during and after severe storms. Maintenance should include clearing of debris from the spillway and discharge channel, clearing of trees and brush from the slopes, and repair of erosion to slopes. All repairs and maintenance should be undertaken in accordance with all applicable State regulations.

(9) Conduct technical inspections of this dam on an annual basis,

(10) institute a definite plan for surveillance of the embankment during and after periods of unusually heavy rainfall and establish a plan to notify residents in case of an emergency at the site.

7.4 Alternatives. There are no recommended alternatives to the program outlined above.

APPENDIX A

PERIODIC INSPECTION CHECKLIST

FALL BROOK RESERVOIR DAM

PERIODIC INSPECTION

PARTY ORGANIZATION

PROJECT FALL BROOK RESERVOIR DATE 4/10/79

TIME 8:30 A.M.

WEATHER Cloudy, 40 F.

W.S. ELEV. 652.2 U.S. n/a DN.S.

PARTY:

1. E. Greco
2. S. Pierce
3. F. Sviokla
4. W. Checchi
5. S. Nagel
6. L. Branagan
7.
8.
9.
10.

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Dam	E. Greco/ S. Pierce/S. Nagel	
2.	Spillway	L. Branagan	
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

PERIODIC INSPECTION CHECK LIST

PROJECT FALL BROOK RESERVOIR DATE 4/10/79

PROJECT FEATURE Main Dam NAME E. Greco

DISCIPLINE Geotechnical NAME S. Pierce

U/S = Upstream; D/S = Downstream

AREA EVALUATED	CONDITIONS
DAM EMBANKMENT Crest Elevation	Earthfill dam with stone masonry core wall D/S side of crest slightly higher than U/S side. D/S side ranges from El.657.0 to 657.7
Current Pool Elevation	652.2
Maximum Impoundment to Date	Unknown
Surface Cracks	Earthen crest; no cracks
Pavement Condition	No pavement Wheel ruts due to minor vehicular traffic
Movement or Settlement of Crest	None evident
Lateral Movement	None
Vertical Alignment	Satisfactory; no apparent settlement
Horizontal Alignment	Straight
Condition at Abutment and at Concrete Structures	Both abutments tie into natural ground; good condition
Indications of Movement of Structural Items on Slopes	No structural items on slopes (see description of gate house)
Trespassing on Slopes	D/S:several large trees; selective clearing in evidence (many stumps left in place). U/S:brush; few small trees
Sloughing or Erosion of Slopes or Abutments	D/S:fair condition:soft; no grass cover. Vines, brush, and moss obscure view of slope U/S:minor erosion at access walk and at spillway
Rock Slope Protection - Riprap Failures	Fair condition:riprap extends about half-way up exposed slope. Some riprap removed by vandals. Brush growing between stones on upper slope.
Unusual Movement or Cracking at or near Toes	None apparent-slope obscured by brush and vines.
Unusual Embankment or Downstream Seepage	D/S:Most of embankment material moist, soft, covered with ferns and swamp-type vegetation in Spring. No evidence of leakage.
Piping or Boils	None visible
Foundation Drainage Features	None visible
Toe Drains	None
Instrumentation System	None

PERIODIC INSPECTION CHECK LIST

PROJECT FALL BROOK RESERVOIR DATE 4/10/79

PROJECT FEATURE Dike NAME E. Greco

DISCIPLINE Geotechnical NAME S. Nagel

AREA EVALUATED	CONDITION
DIKE EMBANKMENT	Earthen dike at south end of pond
Crest Elevation	Varies from 656.2 to 656.6
Current Pool Elevation	652.2
Maximum Impoundment to Date	Unknown
Surface Cracks	Dirt road on crest
Pavement Condition	No pavement
Movement or Settlement of Crest	None
Lateral Movement	None
Vertical Alignment	Relatively flat
Horizontal Alignment	Relatively straight
Condition at Abutment and at Concrete Structures	Dike ties into natural ground at both abutments
Indications of Movement of Structural Items on Slopes	n/a (no structures on dike) Numerous large trees 12-15"ϕ on D/S slope
Trespassing on Slopes	Trash, debris on D/S slope of dike
Sloughing or Erosion of Slopes or Abutments	None-recent dumped fill on D/S slope of dike
Rock Slope Protection - Riprap Failures	Riprap hand-placed on U/S slope - good condition; brush & trees growing in riprap
Unusual Movement or Cracking at or near Toes	U/S: None visible D/S: None visible
Unusual Embankment or Downstream Seepage	No seepage visible
Piping or Boils	None visible
Foundation Drainage Features	None
Toe Drains	None
Instrumentation System	None

PERIODIC INSPECTION CHECK LIST

PROJECT FALL BROOK RESERVOIR DATE 4-10-79

PROJECT FEATURE Gate House NAME E. Greco

DISCIPLINE Structural NAME S. Pierce

AREA EVALUATED	CONDITION
OUTLET WORKS - CONTROL TOWER	Brick superstructure on granite block base; slate roof; built 1896
a. Concrete and Structural	
General Condition	Fair; some mortar missing in brick work, windows and doorway blocked up; door locked but not very sturdy.
Condition of Joints	Fair
Spalling	None (no concrete)
Visible Reinforcing	None
Rusting or Staining of Concrete	N/A
Any Seepage or Efflorescence	None visible
Joint Alignment	U/S face of foundation:one granite block apparently out of alignment about 1 inch
Unusual Seepage or Leaks in Gate	None visible:outlet and service gates submerged under wooden hatch. Outlet gate reportedly closed; service gate open.
Cracks	None
Rusting or Corrosion of Steel	N/A
b. Mechanical and Electrical	No mechanical operators inside gate house would need wrench to operate gates.
Air Vents	N/A
Float Wells	None
Crane Hoist	Wooden beam and rings across U/S wall inside gate house; used for pulling screens
Elevator	N/A
Hydraulic System	N/A
Service Gates	Service gate open, but flow no longer controlled in gate house (see page A-7)
Emergency Gates	Low-level outlet gate closed
Lightning Protection System	None
Emergency Power System	No power
Wiring and Lighting System in Gate Chamber	None; some loose wiring on outside (for lighting)

PERIODIC INSPECTION CHECK LIST

PROJECT FALL BROOK RESERVOIR DATE 4-10-79

PROJECT FEATURE Bridge to gate house NAME E. Greco

DISCIPLINE Structural NAME S. Pierce

AREA EVALUATED	CONDITION
OUTLET WORKS - SERVICE BRIDGE	Wooden footbridge with iron railing and iron facing; iron badly corroding
a. Super Structure	
Bearings	Bolts into granite foundation of gate house D/S end rests on earth embankment
Anchor Bolts	Steel bolts; rusted but in fair to good condition
Bridge Seat	2-by 8-inch wooden beam across base at gate house
Longitudinal Members	Three wooden beams
Under Side of Deck	Open; exposed wooden planks
Secondary Bracing	Some steel rods on short axis
Deck	Bare wood planking - some rotting
Drainage System	None
Railings	Very poor condition-rusted, bent
Expansion Joints	N/A
Paint	None
b. Abutment and Piers	N/A
General Condition of Concrete	
Alignment of Abutment	
Approach to Bridge	
Condition of Seat and Backwall	

PERIODIC INSPECTION CHECK LIST

PROJECT FALL BROOK RESERVOIR DATE 4-10-79

PROJECT FEATURE Intake in gate house NAME E. Greco

DISCIPLINE Geotechnical NAME S. Pierce

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	Stone and brick gate house
a. Approach Channel	No channel-vertical opening in U/S foundation
Slope Conditions	N/A
Bottom Conditions	N/A
Rock Slides or Falls	N/A
Log Boom	2 screens at intake*
Debris	None
Condition of Concrete Lining	N/A
Drains or Weep Holes	N/A
b. Intake Structure	See page A-4
Condition of Concrete	
Stop Logs and Slots	Stop logs above screens; U/S:logs wedged in place, D/S:loose and removable

*Screens are backflushed to clean, can be removed by use of rings and beam across U/S wall of gate house.

PERIODIC INSPECTION CHECK LIST

PROJECT FALL BROOK RESERVOIR DATE 4/10/79

PROJECT FEATURE Outlet pipe NAME E. Greco

DISCIPLINE Geotechnical NAME S. Pierce

AREA EVALUATED	CONDITION
OUTLET WORKS - TRANSITION AND CONDUIT	Low-level outlet is a 30-inch C.I.pipe in stone box culvert through dam. Flow reportedly controlled by valve in gate house. Gate always closed, but apparently leaking.
General Condition of Concrete	No concrete
Rust or Staining on Concrete	-
Spalling	-
Erosion or Cavitation	-
Cracking	-
Alignment of Monoliths	-
Alignment of Joints	-
Numbering of Monoliths	-

NOTE: 24-inch diameter service pipe, gate valve in gate house open. Changes to 20-inch diameter below gate house.

Flow controlled by valve housed in manhole, D/S of dam, to left of low-level outlet.

20-inch diameter pipe leads to chlorinator at Pleasant Street.

Manhole not inspected. Gate valve installed in 1976.

PERIODIC INSPECTION CHECK LIST

PROJECT FALL BROOK RESERVOIR DATE 4/10/79

PROJECT FEATURE Outlet structure NAME E. Greco

DISCIPLINE Geotechnical NAME S. Pierce

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	30-inch C.I. Pipe, silted up 2/3 of opening, never used.
General Condition of Concrete	No concrete; granite block headwall above pipe
Rust or Staining	N/A
Spalling	N/A
Erosion or Cavitation	N/A
Visible Reinforcing	N/A
Any Seepage or Efflorescence	Leakage in area of outlet produces small pool D/S-no flow visible from pipe*
Condition at Joints	Very poor condition- U-shaped headwall collapsed, few traces of mortar in patches
Drain Holes	None
Channel	U-shaped, shallow earth channel
Loose Rock or Trees Overhanging Channel	5 large (12-inch) pines felled across channel, large trees growing on banks.
Condition of Discharge Channel	Poor; cluttered, choked with wood. Channel joins spillway channel D/S of spillway training walls.

*Toe of dam in vicinity of headwall is very soft, moist; may be due to snow melt, seepage, or leaks along conduit through dam.

PERIODIC INSPECTION CHECK LIST

PROJECT FALL BROOK RESERVOIR DATE 4/10/79

PROJECT FEATURE Spillway weir NAME E. Greco

DISCIPLINE Geotechnical NAME S. Pierce

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	Flat, broad-crested stone weir, covered with water, vines, and debris.
a. Approach Channel	Submerged; apparently paved with stone.
General Condition	Fair to poor
Loose Rock Overhanging Channel	Some fallen rock from training walls granite capstone on wing wall appears to have settled U/S into pond
Trees Overhanging Channel	Large tree stump on U/S slope, at left wing wall; vines covering walls.
Floor of Approach Channel	Floor overgrown with bushes, vines, some stumps left from clearing trees.
b. Weir and Training Walls	Dry stone masonry walls with granite capwall; few stones fallen out.
General Condition of Concrete	No concrete, but stone walls in fair to poor condition.
Rust or Staining	None
Spalling	N/A
Any Visible Reinforcing	None
Any Seepage or Efflorescence	None
Drain Holes	4-inch diameter iron pipes drain into channel at base of training wall, 6 on left D/S pipe on left wall is flowing.
c. Discharge Channel	
General Condition	Fair; some chinking missing from walls
Loose Rock Overhanging Channel	None; some rock fallen out of wall into channel.
Trees Overhanging Channel	Many large diameter pines growing on both banks; vines growing on walls.
Floor of Channel	Lined with field stone, filled with vines, brush. Some stumps left from clearing trees.
Other Obstructions	Barbed wire fence across end of stone channel; granite apron at toe of channel.

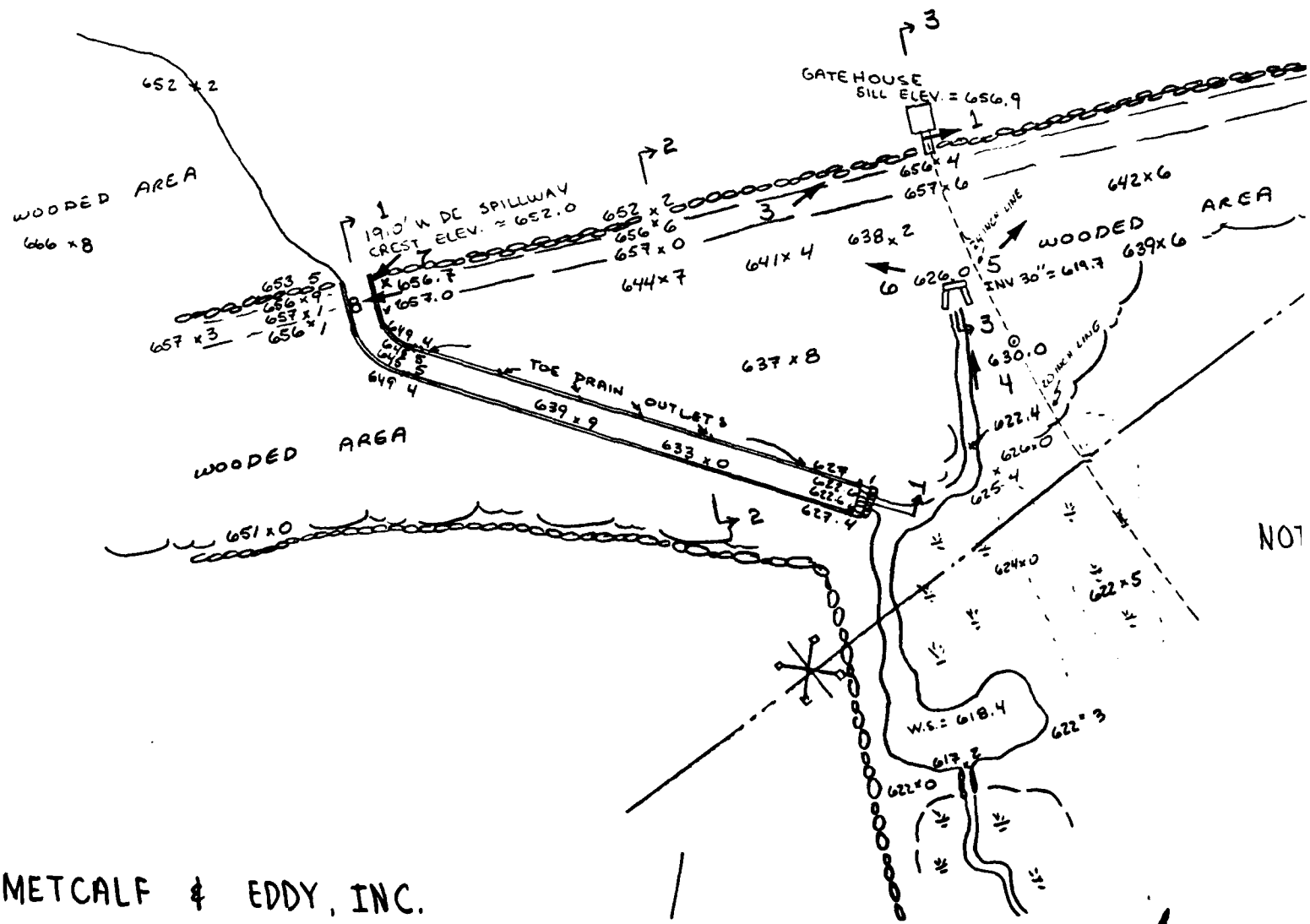
NOTE: Natural earth channel below discharge channel, overgrown with brush and trees. Low earth dike with cut waterway diverts flow.

APPENDIX B

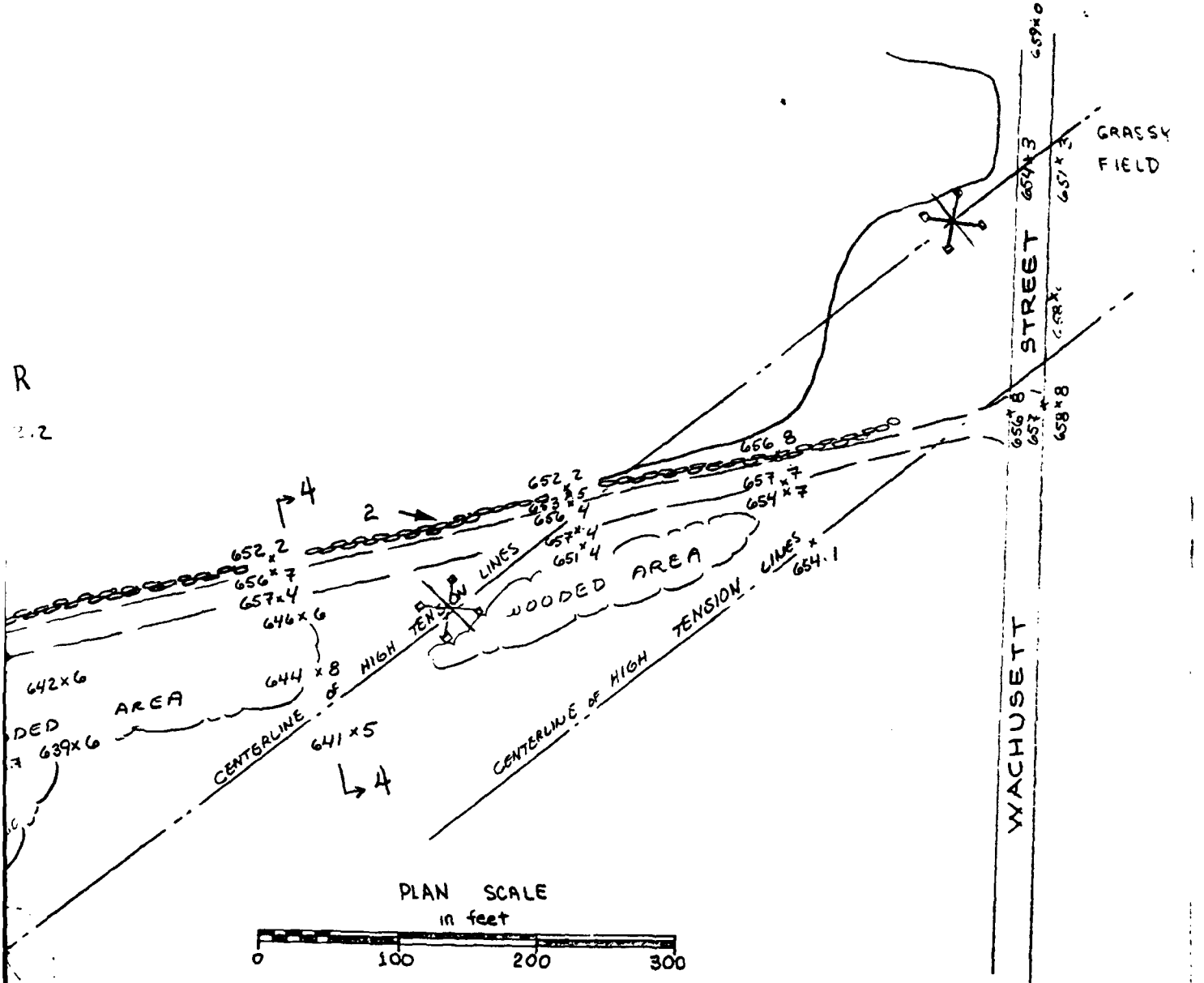
PLAN OF DAM AND PREVIOUS
INSPECTION REPORTS

FALL BROOK RESERVOIR

WATER SURFACE ELEVATION = 652.2



METCALF & EDDY, INC.



NOTES:

1. ELEVATIONS SHOWN BASED ON MONEL SPIKE IN GATEHOUSE ENTRANCE AT ELEV. = 656.9.
2. INFORMATION SHOWN BASED ON FIELD SURVEY OF APRIL 10, 1979
3. 4 DENOTES SEEPAGE
4. ⅓ DENOTES SWAMPY AREA
5. ↗ #2 INDICATES LOCATION AND DIRECTION OF VIEW FOR PHOTOGRAPHS
6. APPROXIMATE LOCATION OF WATER SUPPLY MAIN. INFORMATION PROVIDED BY LEOMINSTER WATER DEPT. --------

METCALF & EDDY, INC.	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS

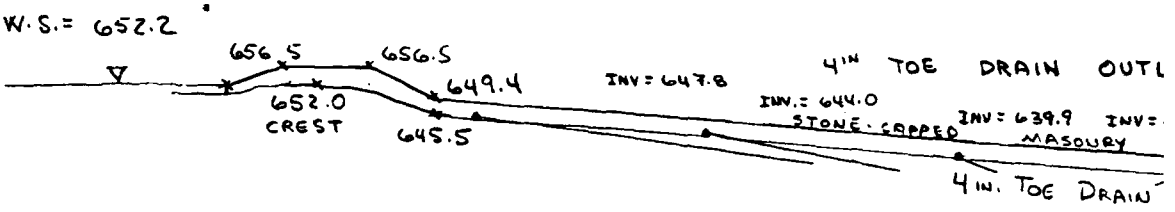
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

FALL BROOK RESERVOIR

FIGURE 2-1 PLAN OF DAM

TRIBUTARY NASHUA RIVER — MASSACHUSETTS

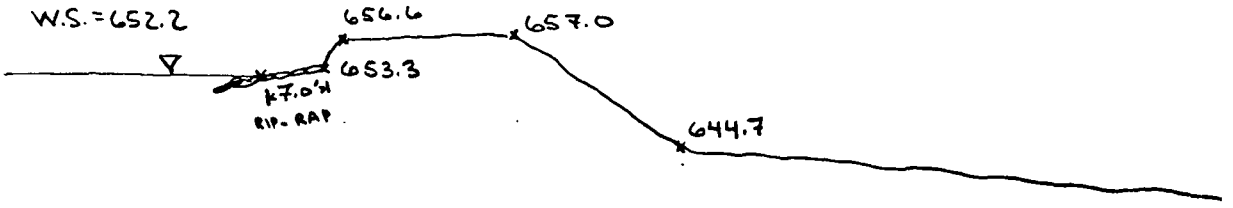
SCALE: 1" = 100' — DATE: MAY, 1979



SECTION 1-1

SPILLWAY

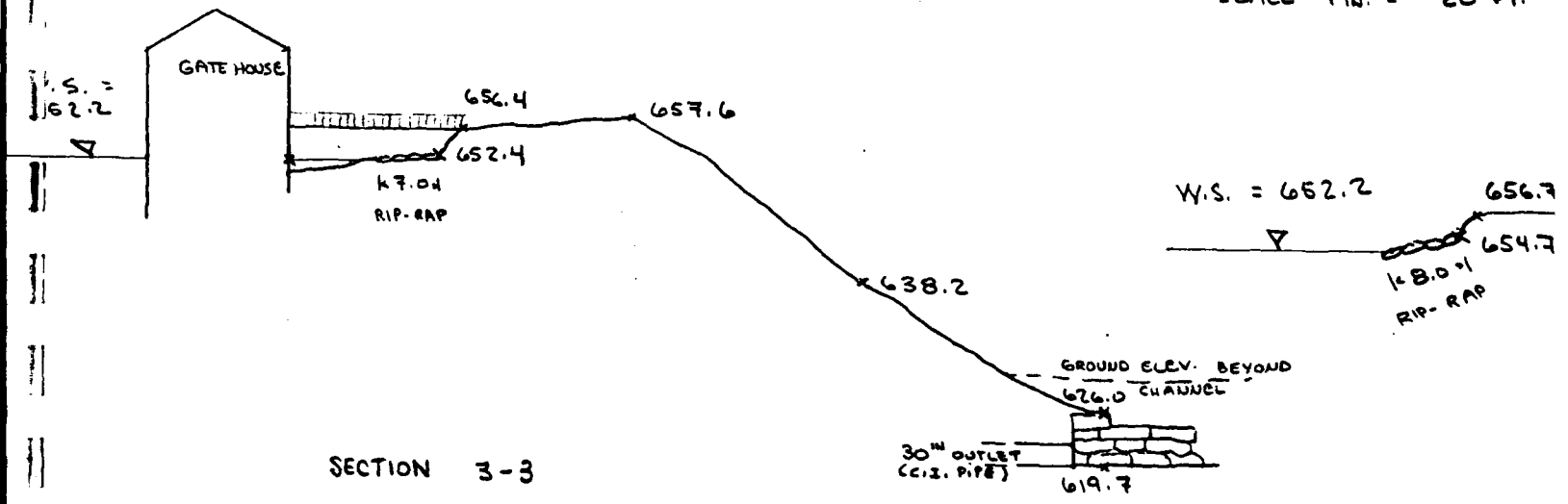
SCALE 1 IN. = 40 FT.



SECTION 2-2

DAM EMBANKMENT

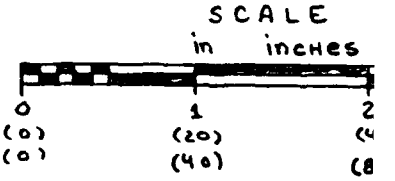
SCALE 1 IN. = 20 FT.



SECTION 3-3

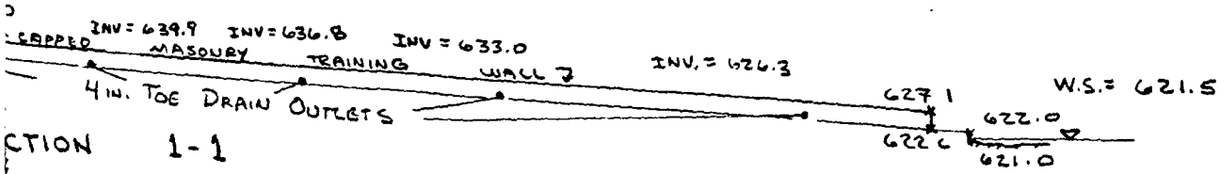
GATEHOUSE - DISCHARGE PIPE

SCALE 1 IN = 20 FT.



METCALF & EDDY, INC.

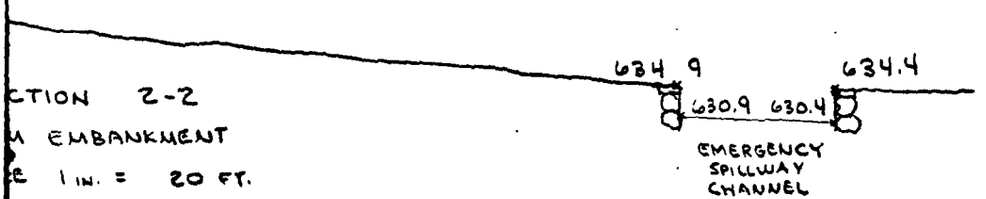
TOE DRAIN OUTLETS



CTION 1-1

SPILLWAY

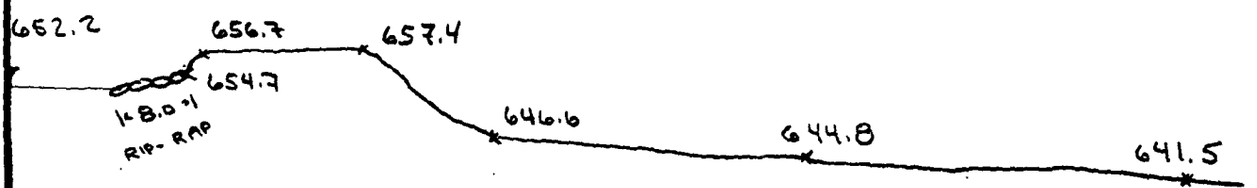
E 1 IN. = 40 FT.



CTION 2-2

M EMBANKMENT

E 1 IN. = 20 FT.



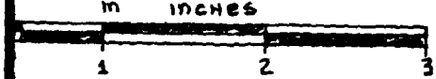
SECTION 4-4

DAM EMBANKMENT

SCALE 1 IN = 20 FT

SCALE

in inches



(20) (40) (60) 20 SCALE

(40) (80) (120) 40 SCALE

METCALF & EDDY, INC. — BOSTON, MA.

U.S. ARMY CORPS OF ENGINEERS — NEW ENGLAND DIV. — WALTHAM, MA.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

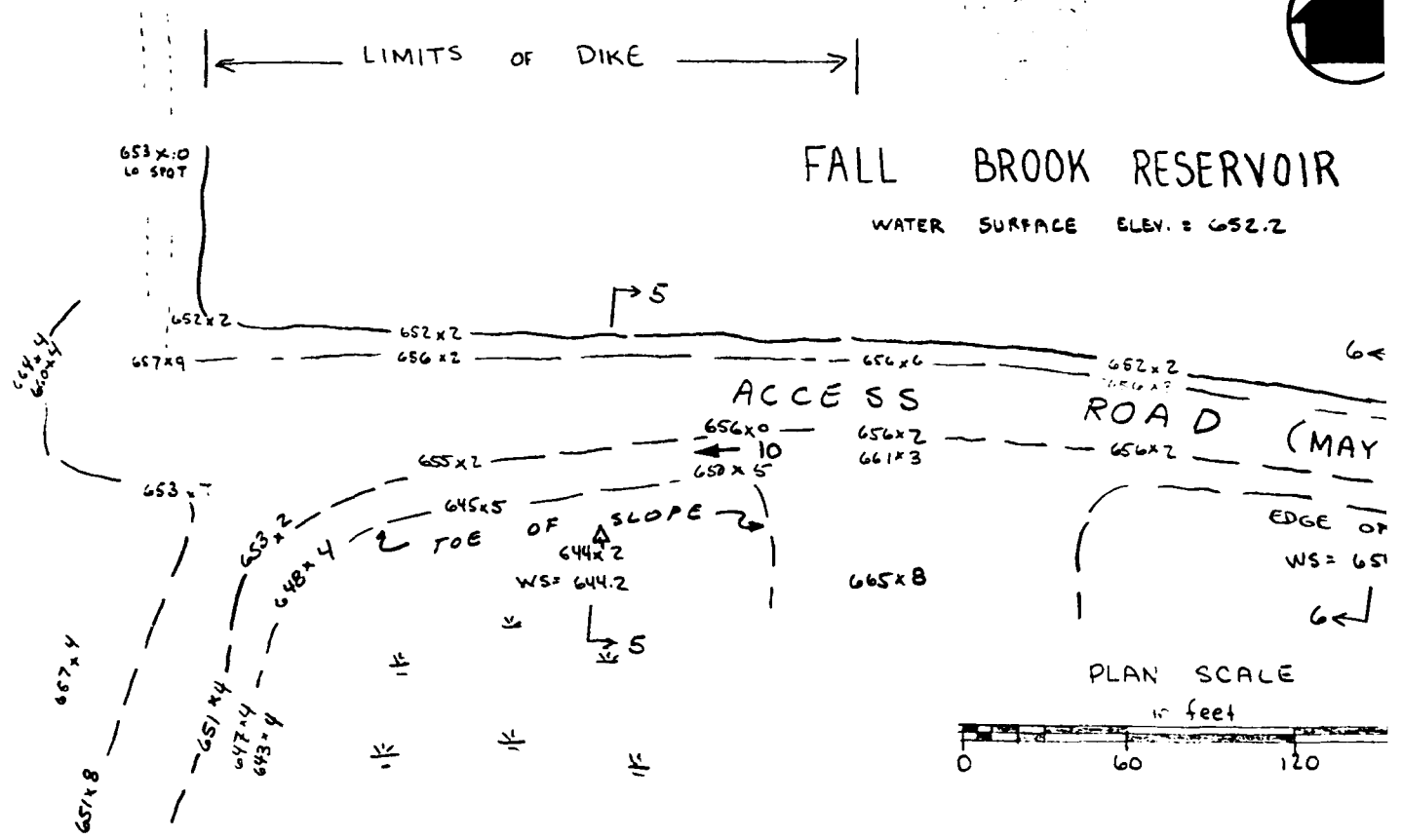
FALL BROOK RESERVOIR

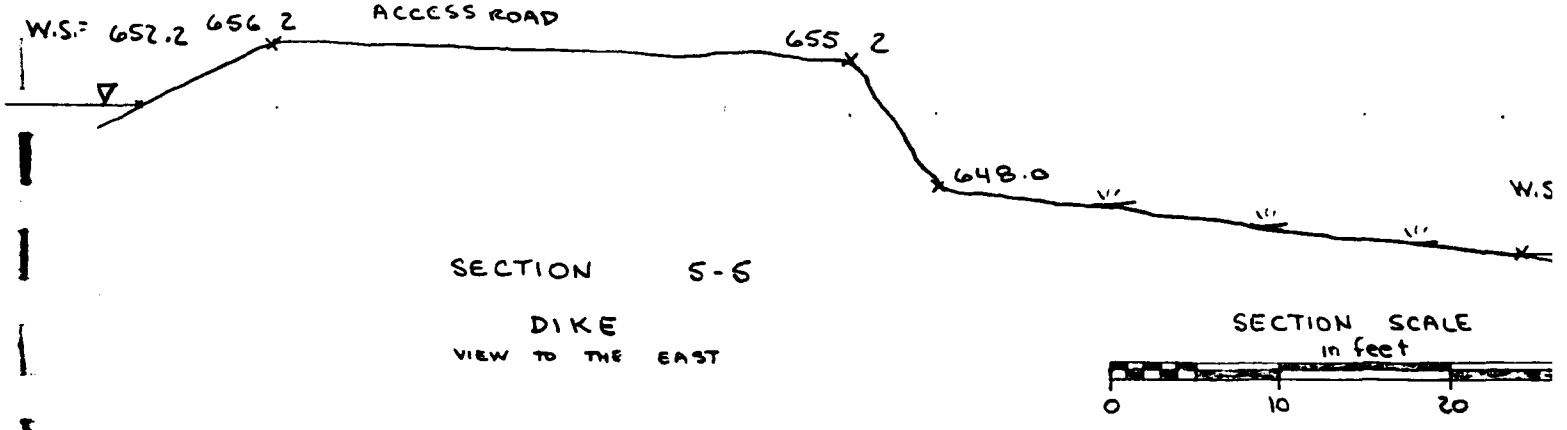
FIGURE 5-2 SECTIONS THROUGH DAM

TRIBUTARY HACKMA RIVER — MASSACHUSETTS

SCALE: AS SHOWN — DATE: MAY, 1979

2





SECTION 5-5

DIKE

VIEW TO THE EAST

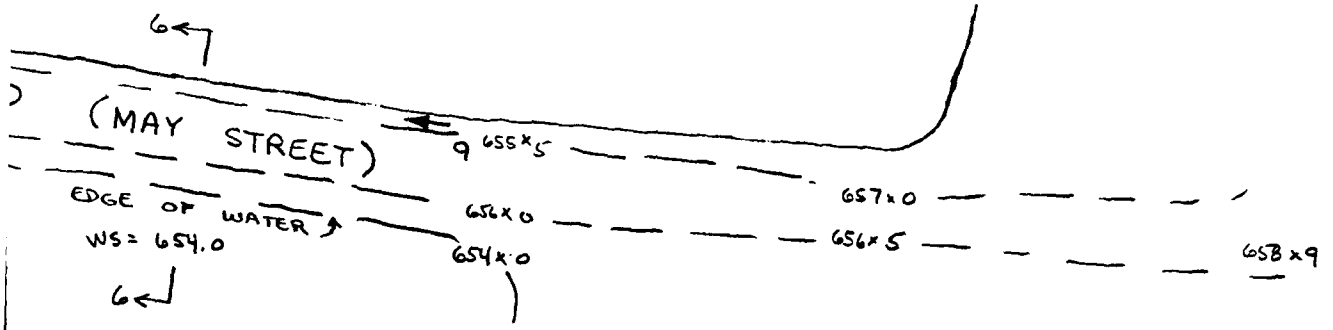
NOTES:

1. ELEVATIONS SHOWN RELATIVE TO RESERVOIR
2. INFORMATION SHOWN BASED ON FIELD
3. ⌇ DENOTES SWAMPY AREA
4. ↗ INDICATES LOCATION AND DIRECTION

METCALF & EDDY, INC.

RVOIR

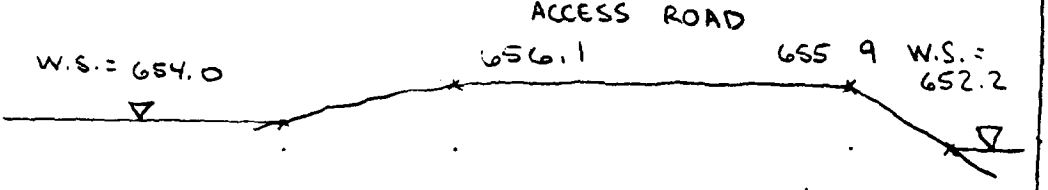
652.2

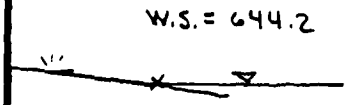


CALE

et

120 180





SECTION 6-6
ACCESS ROAD
VIEW TO THE WEST

SCALE

et

20 30

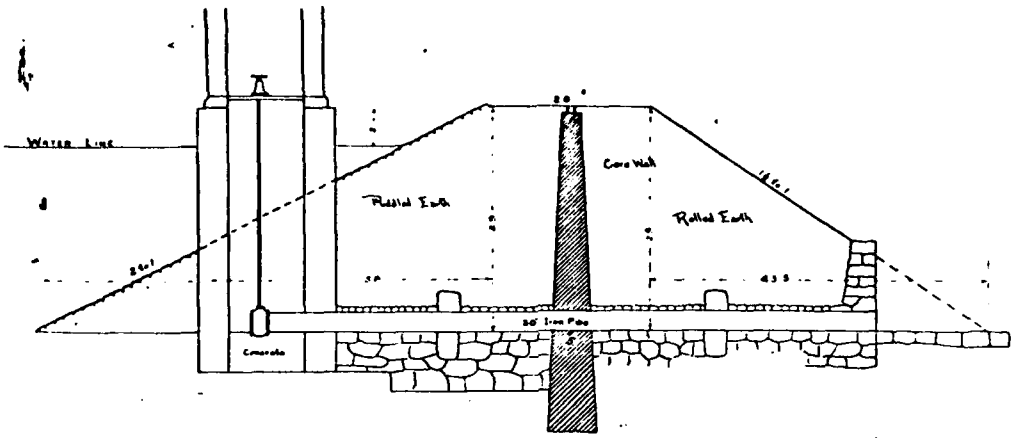
METCALF & EDDY, INC. ENGINEERS BOSTON, MA.	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MA.
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	
FALL BROOK RESERVOIR	
FIGURE B-8 PLAN AND SECTIONS THROUGH DAM	
TRIBUTARY MERRIMACK RIVER	MASSACHUSETTS
SCALE: AS SHOWN	DATE: NOV, 1978

RESERVOIR WATER SURFACE OF APRIL 10, 1979
FIELD SURVEY OF APRIL 10, 1979

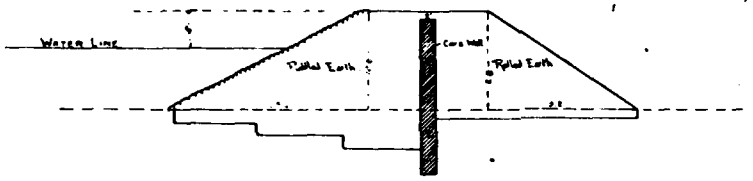
1

ND DIRECTION OF VIEW FOR PHOTOGRAPHS

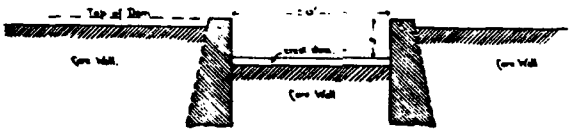
2



SECTION OF DAM SHOWING
GATE-HOUSE



Section of Dike at
Station 3



Rollway

Section on A-B

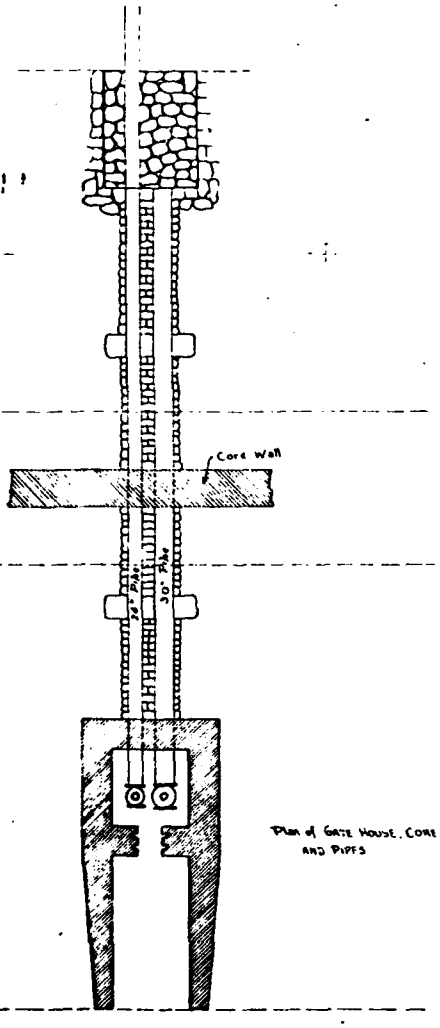
LEOMINSTER WATER WORKS

Details of Dam and Dike

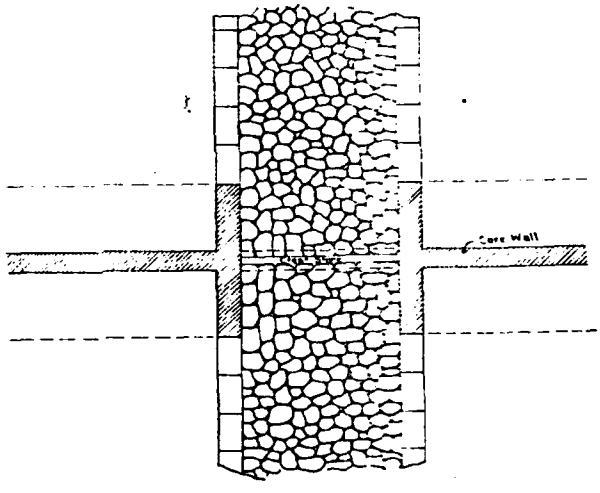
FALL BROOK RESEVOIR

-1895-

Charles A. Allen
Engineer



Plan of Gate House, Core Wall and Pipes



Plan of Rell way.

Scale 10 ft. - 1 Inch

NOTE:
PLAN REDUCED
FOR THIS REPORT

WORCESTER COUNTY COMMISSIONERS
WORCESTER COUNTY ENGINEERING DEPARTMENT
PLAN OF
DAM
ACROSS FALL BROOK
LEOMINSTER, MASS.
FOR THE TOWN OF LEOMINSTER
AS FILED AND APPROVED BY THE
COUNTY COMMISSIONERS
SEPT. 17, 1895
SEPT. MEETING DOCKET 222
SCALES AS NOTED

TRACED BY: M.F.L.C. E.F.K.
TRACING CHECKED BY: J.O.B. 7-2-17

DAM NO. 26-27

J.O. Blanchard COUNTY ENGINEER

FIGURE B-4

TOWN Leominster DAM NO. 21-27 - 27A

LOCATION 200' southerly - Wachusett St STREAM Fall Brook

"Fall Brook Reservoir"

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

Owned by City of Leominster Place Water Dept. Use Water supply

Inspected by W.E. Date Oct. 2, 1964.

Type of Dam Earth and stone Condition Good

SPILLWAY

Flashboards in Place No boards Recent Repairs

Condition There is some small brush in the spillway.

Repairs Needed Some repainting mark is required to the stone abutment walls. The present water level is down about 18".

EMBANKMENT

Recent Repairs The embankment is covered with brush and trees.

Condition (The dike at 21-27A on the southerly end of the reservoir

Repairs Needed is a highway embankment (Mayo St.) - It is 20' long - 25' wide on top - 12' high - 1½ to 1 slopes - riprap on the upstream slope.)

GATES

Recent Repairs

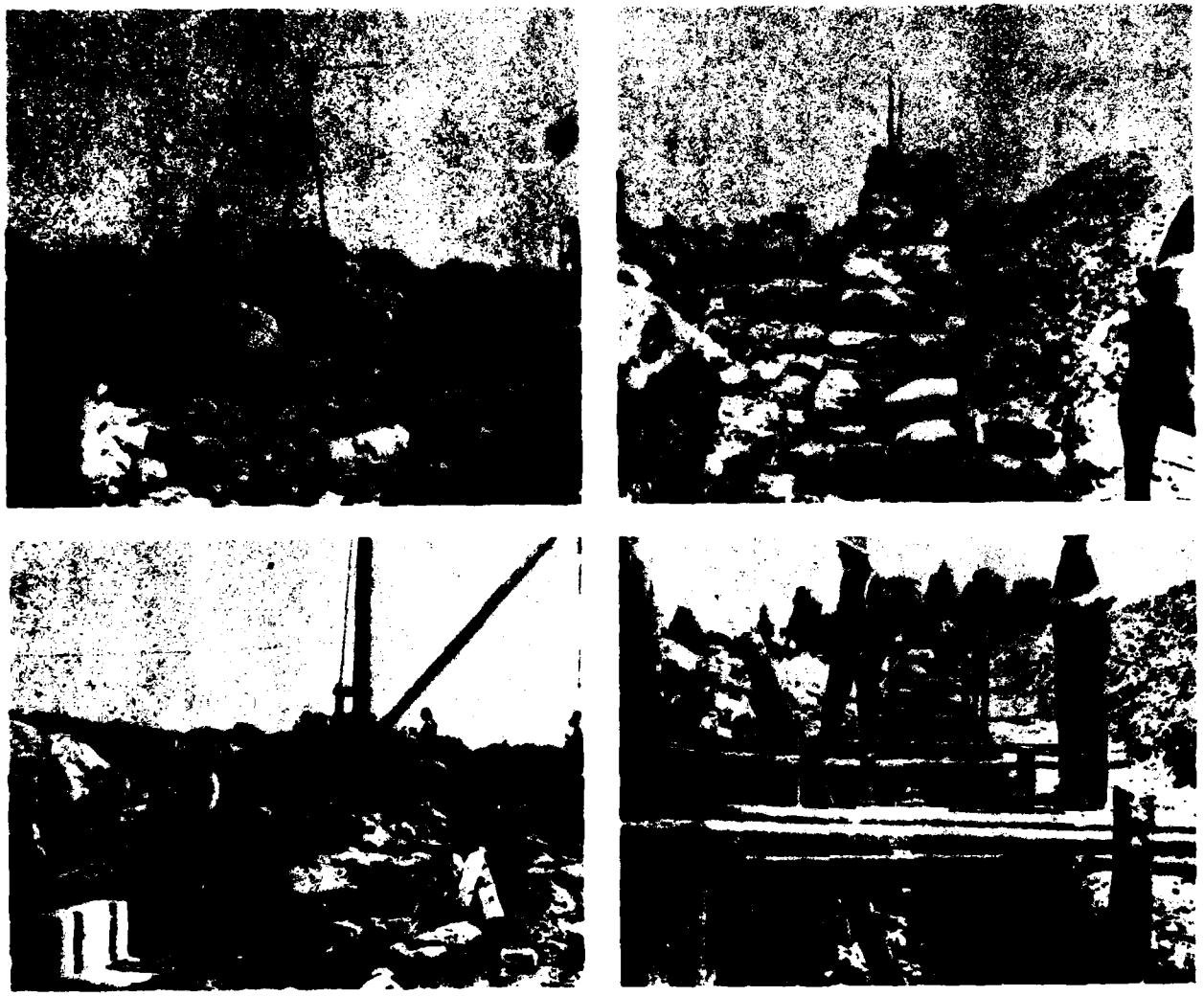
Condition The gate is located in a locked gate house.

Repairs Needed

LEAKS

How Serious No leaks.

DATE: County Engineer



Photographs courtesy of Water Division
Leominster Department of Public Works

CONSTRUCTION PHOTOGRAPHS - FALL BROOK RESERVOIR - 1896

Photographs courtesy of Water Division
Leominster Department of Public Works

SECTION OF CORE WALL - FALL BROOK RESERVOIR - JULY 18, 1896

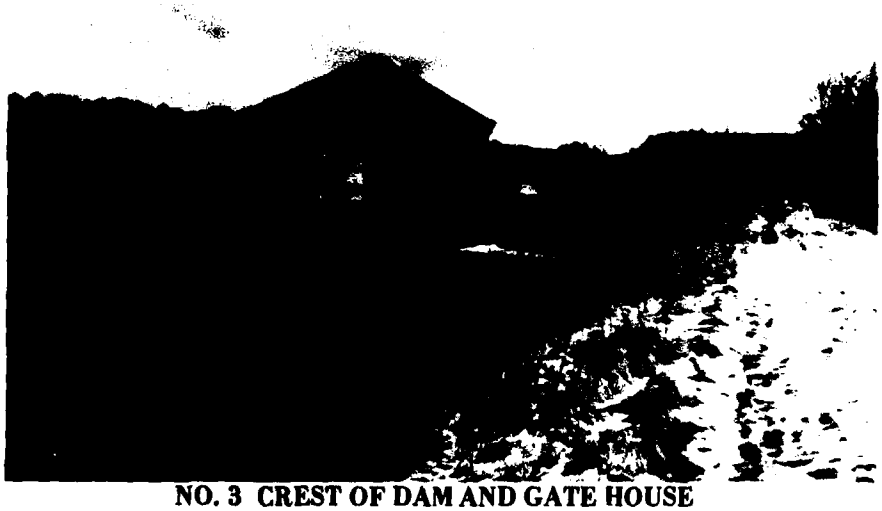
APPENDIX C

PHOTOGRAPHS

LOCATION AND DIRECTION OF PHOTOGRAPHS
INDICATED ON FIGURE B-1 IN APPENDIX B

NO. 1 CREST OF DAM (MAY 17 PHOTO)

NO. 2 RIPRAP ON UPSTREAM SLOPE

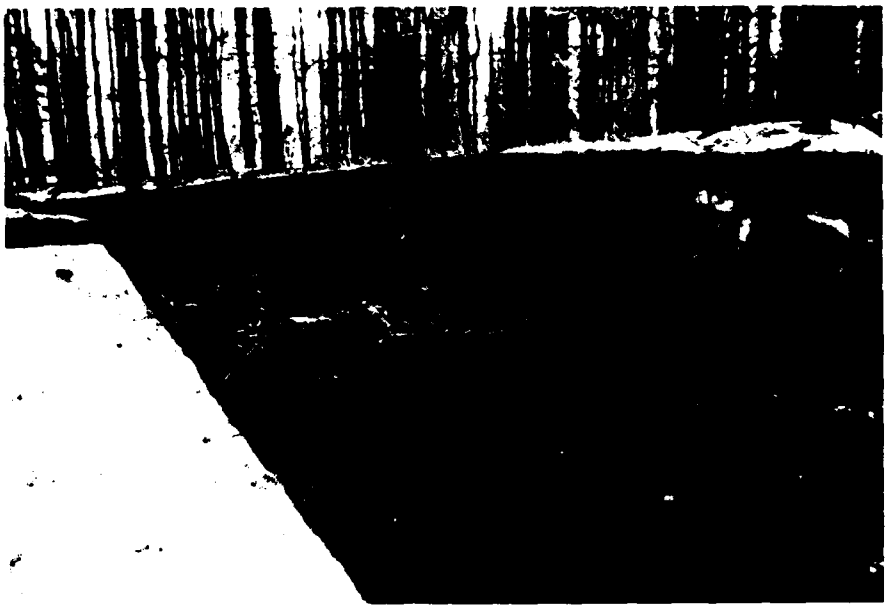


NO. 3 CREST OF DAM AND GATE HOUSE

NO. 4 OUTLET AND WING WALLS AT DOWNSTREAM TOE OF DAM
(MAY 17 PHOTO)

NO. 5 PARTIALLY CLEARED DOWNSTREAM SLOPE
(MAY 17 PHOTO)

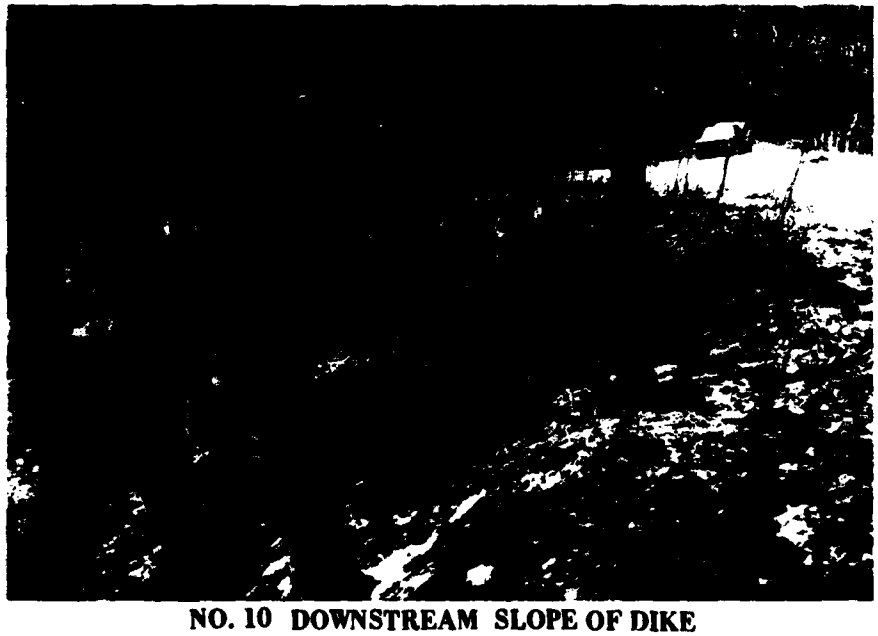
NO. 6 DOWNSTREAM SLOPE
(MAY 17 PHOTO)



NO. 7 SPILLWAY CHANNEL AND TRAINING WALLS

NO. 8 CREST OF SPILLWAY
(MAY 17 PHOTO)

NO. 9 CREST AND UPSTREAM SLOPE OF DIKE



NO. 10 DOWNSTREAM SLOPE OF DIKE

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

FALL BROOK RESERVOIR DAM

Project Nat. Review of Non Fed. Dams Acct. No. 6356 Page 1 of 6
Subject Worcester County, Mass. Compld. By LEB Date 5/14/79
Detail FALL BROOK RESERVOIR Ck'd. By W.C. Date 5/23/79

(I) Test Flood, Storage & Storage Functions

1- Total Drainage Area - 1.31 mi²

2- Pond(s) Area: 0
Swamp(s) Area: 0.03
Total Area Pond(s) & Swamp(s): 0.03

% Ponds & Swamps = $\frac{0.03}{1.31}$ = 2%

3- $\frac{1070-651}{3700}$ = 11.3%; $\frac{1068-651}{7200}$ = 5.8% } Say Ave Slope = 8%

4- Using C. of E. Curves for Peak Flow Rates & above guide values, the Peak Flow Rate was estimated to be slightly above "Mountainous" and taken at 2800 c.f.s./mi²
Size Class: Inter. ; Hazard Pot.: High ; Spill. Des. Flood: Full PMF
Use: Test Flood = Full PMF

5- Test Flood Inflow = (1.31) 2800 = 3670 c.f.s.

6- Pond Storage
The pond area is 0.13 sq. mi. at elev. 652.0
Based on a const. area, storage increases at 82.6 ac. feet per foot of depth increase.

7- Spillway crest elev. is 652.0

8- Storage Functions are based on $Q_{out} = Q_{in}\left[1 - \frac{S_{out}}{R}\right]$
S_{out} = Storage Vol. in Reservoir related to final Q_{out} in terms of inches of rain over the drainage area.

S(in Inches) = $12\,D\left(\frac{0.13}{1.31}\right)$ = 1.19 D ; R = 6hr rain of storm.
D = Storage depth in feet above spillway crest in reservoir

9- Storage Functions: (Test Flood & ½ PMF - if needed)

F_{TF} = 3670 - 193 S = 3670 - 230 D	
$F_{½PMF}$ = 1835 - 193 S = 1835 - 230 D	

Project Nat. Review of Non Fed. Dams Acct. No. 6356 Page 2 of 6
Subject Worcester County, Mass Comptd. By LEB Date 5/16/79
Detail FALL BROOK RESERVOIR Ck'd. By W.C. Date 5/23/79

(II) Discharge Ratings

A. Spillway: Width - 19', Elev. - 652.0, Crest - peaked, broad

Use Williams & Hazen "Hyd. Tables" with multiplier of 0.92 (Type P crest)

$Q = 19(.92)\,q = 17.48\,q$, let $q = 30.0$ for pond elevs.

Pond El.	653	654	655	656	657	658	659
q	3.33	9.32	17.10	26.35	36.88	48.67	60.5±
Q_A	60	160	300	460	640	850	1060±

Note: No Flashboards or stoplogs - but irregular stones across crest tend to back up reservoir. Stones may be removed by high flows.

B- Low Level Outlet:

30 in. ϕ outlet pipe, ℄ outlet el. 621±,

Ent., Exit & Gate Loss ≈ $1.5\,V^2/2g$; Say Frict ≈ $.02\left(\frac{120}{2.5}\right)V^2/2g \approx 1.0\,V^2/2g$

∴ Head = $2.5\,V^2/2g = H_f$; $A = \left(\frac{2.5}{2}\right)^2\pi = 4.91\,ft^2$

Pond El. = 252, H = 652 - 621 = 31', V = 28 fps, Q = 138.8 cfs
Pond El. = 251, H = 30', V = 28 fps, Q = 136.5 cfs.

Ave = $\frac{138.8 + 136.5}{2} = 137.6$ cfs.

Time to Drain 1 ft down from pond elev. 652 –

$$\frac{82.6\text{ ac.}\,(43560)}{137.6\text{ cfs}} = 7.26\text{ hours.}$$

C- Crest Flow - Southerly Dike.

Assume 330' at westerly end can discharge to significant waterway, 150' @ el. 656.2±, 90' @ el. 656.4±, 90' @ el. 656.6

Use $q = 2.55\,H^{1.5}$ [Ref. V.T. Chow - pg 52-53]

Pond El.	656.5	657.0	658.0	659.0
Q_1	60	270	920	1790
Q_2	10	110	460	960
Q_3	—	60	380	850
ΣQ_C	70	440	1760	3600

Project	Nat. Review of Non. Fed. Dams	Acct No	6356	Page	3 of 6
Subject	Worcester County, Mass	Comptd By	LEB	Date	5/16/79
Detail	FALL BROOK RESERVOIR	Ck'd By	W.C.	Date	5/23/79

(II) Discharge Ratings - Cont.

D - Crest Flow - Main Dam

Use $q = 2.55 H^{1.5}$ as in "C"

Assume: 265' @ 657.0 ; 490' @ 657.4; 290' @ 657.6

Pond Elev.	657.5	658	659
Q_1	240	680	1910
Q_2	40	580	2530
Q_3	—	190	1220
ΣQ_0	280	1450	5660

(III) Crest Disch. Conditions

A - Main Dam

Max Depth = 657.6 - 657 = 0.6'

$q = 2.55 (0.6)^{1.5} = 1.18$ cfs/ft (max)

As Critical Flow: $y_c = 0.35$ ft, $V_c = 3.35$ fps

B - Southern Dike

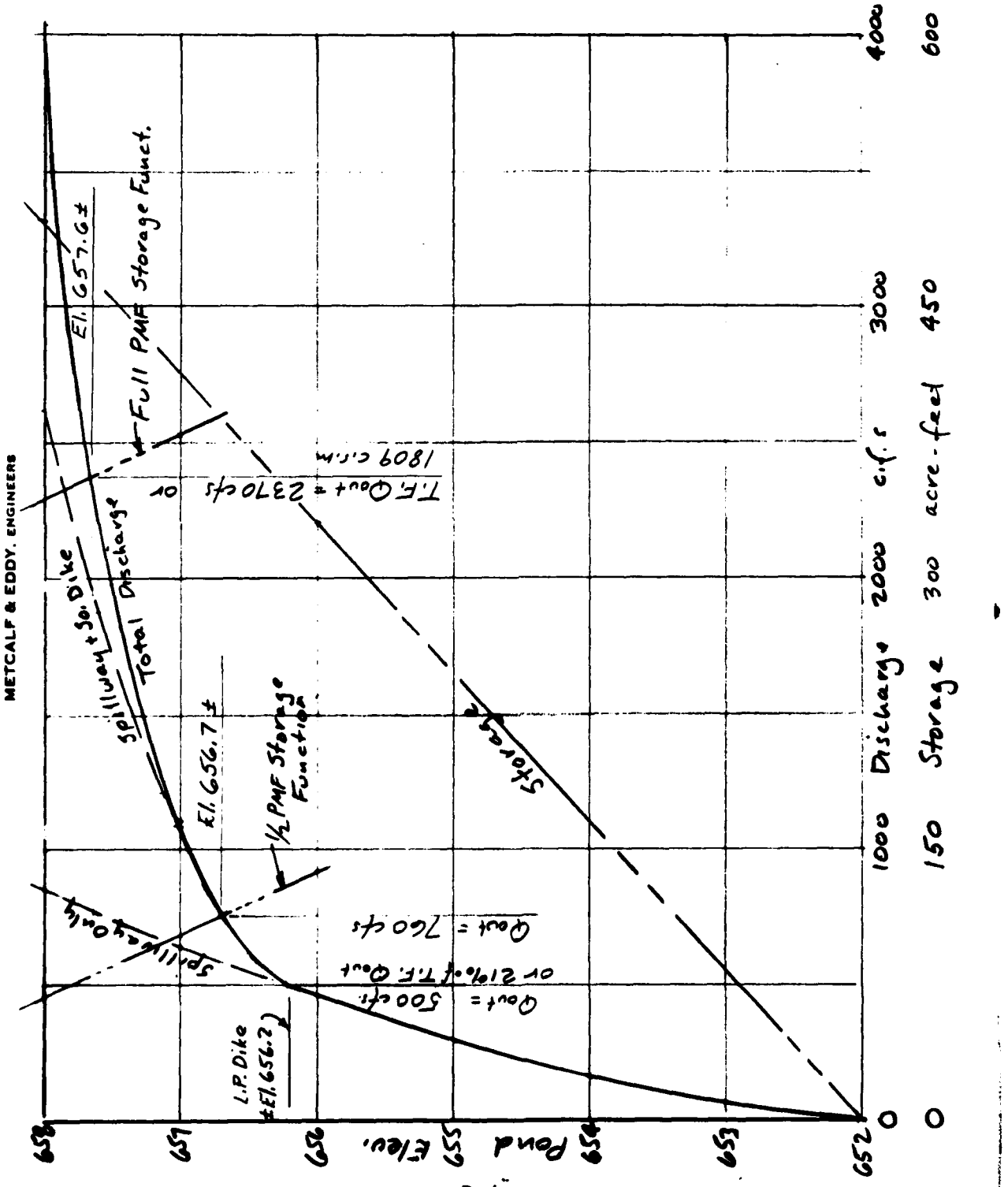
Max Depth = 657.6 - 656.2± = 1.4'

$q = 2.55 (1.4)^{1.5} = 4.22$ cfs/ft (max

As Critical Flow: $y_c = 0.82$ ft, $V_c = 5.14$ fps.

Project Nat. Review of Non Fed. Dams Acct. No. 6356 Page 4 of 6
Subject Worcester County, Mass. Comptd. By LBB Date 5/16/79
Detail FALL POND RESERVOIR Ck'd. By W.C. Date 5/23/79

(IV) Discharge, Storage & Storage Function vs Res. Elev.



Project Nat. Review of Non Fed. Dams Acct. No. 6356 Page 5 of 6
Subject Worcester County, Mass. Compt'd. By LEE Date 5/14/79
Detail FALL BROOK RES. Ck'd. By W.C. Date 5/23/79

NONREPRODUCIBLE GRID FORM 145

METCALF & EDDY, ENGINEERS

(V) Failure of Dam

Peak Failure Flow:

Pond Elevation - 657.0 (low pt. dam crest)
Toe Elevation — 630.0
Y_o = 27.0

Dam Length Subject to Breaching = 400
$W_o = 40\%(400) = 160$ ft.

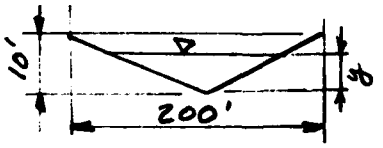
$$Q_{P_1} = 1.68\, W_o (Y_o)^{1.5} = 1.68(160)(27)^{1.5} = 37700$$

Channel Flow (Spillway Only) = 640 cfs; Total ≃ 38300 cfs

Storage Volume Released:

Storage Above Spillway 5(82.6) = 413 ac. ft
Storage Below Spillway [City Data] 1286 " "
S = Total Storage = 1699 " "

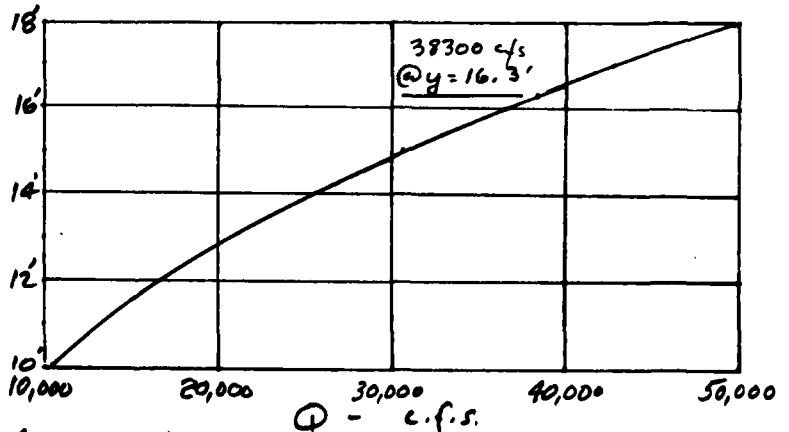
Channel Hydraulics:



$A \simeq 10y^2$; $R \simeq \frac{1}{2}y$, $n \simeq 0.08$, $S = \frac{40}{1100} = .03636$

$$V = \frac{1.49}{.08}\left(\frac{y}{2}\right)^{2/3}(.03636)^{1/2} = 2.24\, y^{2/3}$$

y	A	V	Q
5	250	6.55	1,640
10	1000	10.4	10,400
15	2250	13.6	30,600
16	2560	14.2	36,400
17	2890	14.8	42,800
18	3240	15.4	49,800
4	160	5.64	900
3	90	4.66	420



Channel Depth Rises from 3.5'± to 16.3' at failure

Time to Drain:

$$\frac{43560\ (1699)}{3600(\frac{1}{2})(39700)} = 1.09 \text{ Hours.}$$

Project Nat. Review of Non Fed. Dams Acct. No. 6356 Page 6 of 6
Subject Worcester County, Mass. Comptd. By LEB Date 5/14/79
Detail FALLS BROOK RESERVOIR Ck'd. By W.C. Date 5/23/79

(VI) Failure of Dike (Westerly End)

Peak Failure Flow:

Pond Elevation - 656.2 (low pt. dike crest)
Toe Elevation — 645.5
Y_o = 10.7

Dam Length Subject to Breaching = 165 ft.

$W_o = 40\%(165) = 66$ ft.

$$Q_{P_1} = 1.68\, W_o (Y_o)^{1.5} = 1.68(66)(10.7)^{1.5} = 3880 \text{ cfs.}$$

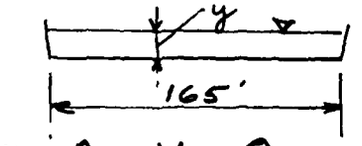
Storage Volume Released:

Storage Above Spillway 4.2(82.6) = 347 ac.ft.
Storage Below Spillway [City Data] = 1286 " "
S = Total Storage = 1633 " "

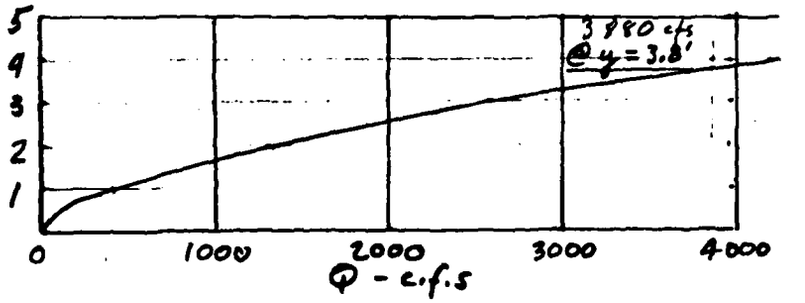
Channel Hydraulics:

$A \simeq 165y$; $R \simeq y$, $n \cong 0.1$, $S = \frac{10}{350} = .0286$

$$V = \frac{1.49}{0.1}(y)^{2/3}(.0286)^{1/2} = 2.5\, y^{2/3}$$



y	A	V	Q
2	330	4.0	1320
4	660	6.3	4190
3	495	5.2	2590
1	165	2.5	410



Discharge - 3.8 ft deep @ 6.1 fps.

Time to Drain:

$$\frac{43560\,(1633)}{3600(\frac{1}{2})(3880)} = 10.2 \text{ Hours.}$$

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

FALL BROOK RESERVOIR DAM

INVENTORY OF DAMS IN THE UNITED STATES

(1) NTITY MBER	(2) DIVISION	(3) STATE	(4) COUNTY	(5) CONGR DIST.	(6) STATE	(7) COUNTY	(8) CONGR DIST.	(9) NAME	(10) LATITUDE (NORTH)	(11) LONGITUDE (WEST)	(12) REPORT DATE DAY | MO | YR
869	NED	MA	027	04				FALL BROOK RESERVOIR DAM	4229.8	7146.8	08JUN79

(13) POPULAR NAME	(14) NAME OF IMPOUNDMENT
	FALL BROOK RESERVOIR

(15) REGION	(16) BASIN	(17) RIVER OR STREAM	(18) NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	(19) DIST FROM DAM (MI.)	(20) POPULATION
01	06	TR-NASHUA RIVER	LEOMINSTER	0	35430

(21) TYPE OF DAM	(22) YEAR COMPLETED	(23) PURPOSES	(24) STRUCTURAL HEIGHT (FT.)	(25) HYDRAULIC HEIGHT (FT.)	(26) IMPOUNDING CAPACITIES MAXIMUM (ACRE-FT.)	(27) IMPOUNDING CAPACITIES NORMAL (ACRE-FT.)	DIST	OWN	FED	R	PRV/FED	SCS	A	VER/DATE
ERPGOT	1896	C	37	37	1633	1286	NED	N		N		N		

(28) REMARKS
21-STONE MASONRY CORE

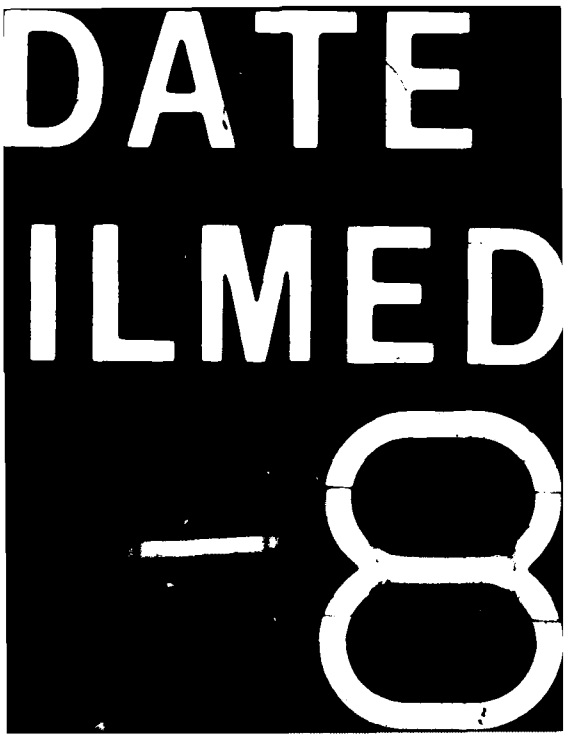
(29) D/S HAS	(30) SPILLWAY CREST LENGTH	(31) SPILLWAY TYPE	(32) SPILLWAY WIDTH (FT.)	(33) MAXIMUM DISCHARGE (CFS.)	(34) VOLUME OF DAM (CY)	(35) POWER CAPACITY INSTALLED (MW)	(36) POWER CAPACITY PROPOSED (MW)	(37) NAVIGATION LOCKS NO.	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (CFS)
1	1392	U	19	500	81000											

(38) OWNER	(39) ENGINEERING BY	(40) CONSTRUCTION BY
CITY OF LEOMINSTER	CHARLES A ALLEN	UNKNOWN

(41) REGULATORY AGENCY			
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	NONE	NONE

(42) INSPECTION BY	(43) INSPECTION DATE DAY | MO | YR	(44) AUTHORITY FOR INSPECTION
METCALF AND EDDY INC	10APR79	PL 92-367

(45) REMARKS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